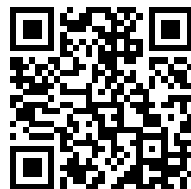

This is a reproduction of a library book that was digitized by Google as part of an ongoing effort to preserve the information in books and make it universally accessible.

GoogleTM books

<https://books.google.com>



VICE
CAL
EDS'
NAL

16

Post

TTA

Digitized by Google



Post

b
Ag 25 '17

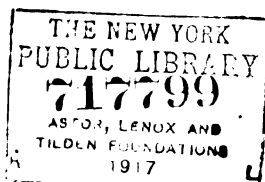
THE POST OFFICE ELECTRICAL ENGINEERS' JOURNAL



VOLUME
VIII



APRIL 1915
TO
MARCH 1916



= The Post Office = Electrical Engineers' Journal.

THE ORGAN OF THE INSTITUTION
OF POST OFFICE ELECTRICAL ENGINEERS.

**A QUARTERLY JOURNAL DEVOTED TO:
Telephones, Telegraphs (Aerial, Underground,
Submarine and Wireless) and all matters of
Interest to Communication Engineers.**

EDITED BY:

T. F. PURVES, M.I.E.E.
A. W. MARTIN, A.M.I.E.E.
Major A. C. BOOTH, R.E.

J. W. ATKINSON, A.M.I.E.E.
A. O. GIBBON, A.M.I.E.E.
W. T. HARRIS.

W. CRICKSHANK, A.M.I.E.E.
(Managing Editor.)

(Office of the Engineer-in-Chief, G.P.O., London, E.C.)

VOLUME VIII.

No. 1—April, 1915	...	Pages	1—92
No. 2—July, 1915	...	„	93—192
No. 3—October, 1915	...	„	193—280
No. 4—January, 1916	...	„	281—364

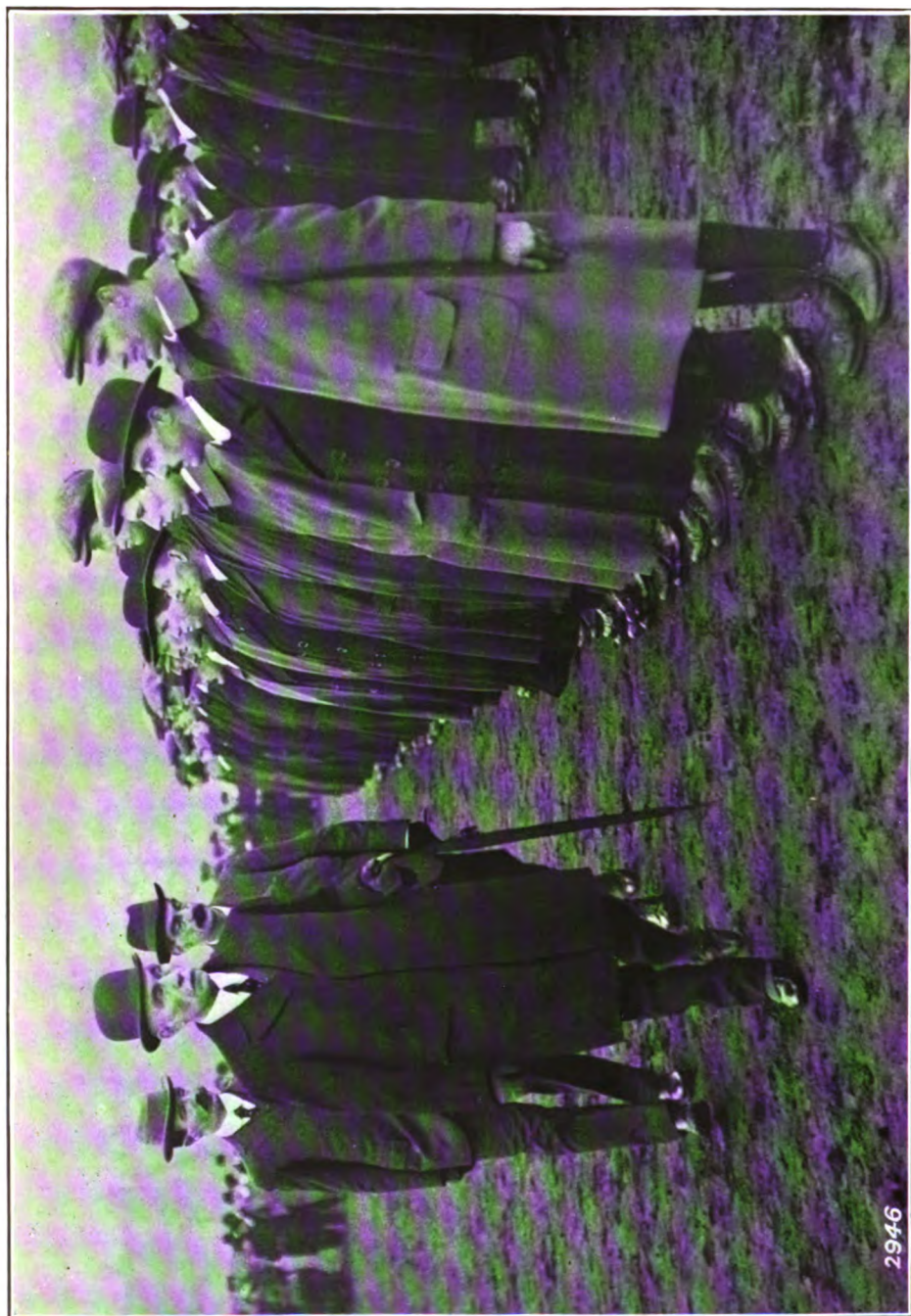
INDEX.

	PAGE
A Descriptive Account of Cable Desiccating Operations at Halifax !	227
A New Type-Printing Multiplex Telegraph. A. H. Roberts	193
An Early Cable Experiment. J. T. L.	118
Automatic Exchanges, Subscribers' Station Coin Box and Call Meter for. J. H. Watkins	22
Balancing of Duplex Circuits, The. E. V. Smart	330
Baudot Tests, Duplex. Major A. C. Booth, R.E.	13
Book Reviews	88, 358
Cardiff Post Office Electrical Supply. W. Scott	68
Circuit Development, Trunk and Junction. I. H. Jenkins, A.M.I.E.E., and H. W. White	281
City Telephone Exchange Power Plant, London	108
Collapse of Iron Poles at Brighton, The. C. T. Crisp	302
Constitution of Low Tariff Telephone Area and the Laying-out of a Large Area. T. F. Purves, M.I.E.E.	336
Contracts, Engineering. W. Laws	168
Correspondence	330
Council Notes	82, 271, 354
Developments in the Strowger Automatic System. J. Hedley	127
Duplex Baudot Tests. Major A. C. Booth, R.E.	13
Eden, Augustus. A. J. S.	345
Editorial Notes and Comments	72, 175, 253
Electric Light and Power Circuits, Overhead	309
Engineering Contracts. W. Laws	168
Engineering Officers holding Commissions in the Army or Navy	177, 278, 357
Errata	212
Fire Alarm Circuits in Post Office Buildings. J. L. T.	105
Headquarters Notes	75, 181, 269, 342
Honour bestowed upon the Engineer-in-Chief of the British Post Office	93
How to Illustrate your Lectures and Articles. H. A. Miles	247
Iron Poles at Brighton. The Collapse of. C. T. Crisp	302
Lectures and Articles, How to Illustrate your. H. A. Miles	247
Letter-Stamping Machines. A. B. Eason, M.A.	319
Library Notes	89
Lieut. Greely and his Patent Insulator	245
Line-Testing, The Simplification of. G. F. Tanner, A.M.I.E.E.	237
Loaded Trunk Telephone Cables, Termination of. T. F. Purves, M.I.E.E.	110
Local Centre Notes	83, 188, 355
Local Lines and Instruments, Maintenance of. W. D. Scutt	227

	PAGE
London-Birmingham Loaded Cable. J. G. H.	206
London District Notes	77, 184, 272, 343
Machinery, Letter-Stamping. A. B. Eason, M.A.	319
Maintenance of Local Lines and Instruments. W. D. Scutt	227
Martin, The late W. James. J. R. M. E.	353
Mentioned in Despatches	276
Military Honours	359
New York to San Francisco Telephone Line, The. J. G. H.	28
Notes on the Transfer of Small Exchanges. W. S. Tinsley	58
"Nothing New under the Sun." T. F. Purves, M.I.E.E.	18
Obituary	180
O'Meara, Major W. A. J., C.M.G., R.E.	271
Overhead Electric Light and Power Circuits	309
Personal	226
Plant Supply, The Regulation of. F. G. C. Baldwin, A.M.I.E.E.	47
Post Office Engineering. V. T. C.	1, 102, 265
Power Plant, City Telephone Exchange, London	108
Regulation of Plant Supply, The. F. G. C. Baldwin, A.M.I.E.E.	47
Roll of Honour	89, 190, 274, 362
Screened Cable Conductors and their Application in Telegraph Service. R. E. Chetwood	240
Signal-Master on Active Service, A.	262, 333
Sir William Slingo, Engineer-in-Chief, G.P.O.	93
Small Exchanges, Notes on the Transfer of. W. S. Tinsley	58
Snow-Storm Damage in London. A. Moir, M.I.E.E.	6
Staff Changes	91, 191, 229, 363
Stroh, Augustus. H. R. K.	180
Strowger Automatic System, Developments in the. J. Hedley	127
Study of Telephone Traffic Problems with the Aid of the Principles of Probability. W. H. Grinsted, A.M.I.E.E.	33
Subscribers' Station Coin Box and Call Meter for Automatic Exchanges. J. H. Watkins	22
Telegraph, A New Type-Printing Multiplex. A. H. Roberts.	193
Telephone Line, New York to San Francisco. J. G. H.	28
Telephone Traffic Problems, The Study of, with the Aid of the Principles of Probability. W. H. Grinsted, A.M.I.E.E.	33
Termination of Loaded Trunk Telephone Cables. T. F. Purves, M.I.E.E.	110
The Incompleteness of the Present Theory of Telephone Transmission. F. Murphy, B.Sc.	122, 213
The Simplification of Line-Testing. G. F. Tanner, A.M.I.E.E.	237
Theory of Double Current Duplex. A. B. Morice, B.Sc.	254
Tremain, Mr. F. H. P. B.	349
Trench Telephones. T. F. Purves, M.I.E.E.	95
Trunk and Junction Circuit Development. I. H. Jenkins, A.M.I.E.E., and H. W. White	281
Two Edinburgh Section D.C.M.'s	360
Wireless Telegraphy and Submarines	243

THE NEW YORK
PUBLIC LIBRARY

ASTOR, LENOX AND
TILDEN FOUNDATIONS



THE POST OFFICE ENGINEERING VOLUNTEER TRAINING CORPS. INSPECTION BY GENERAL SIR O'MOORE CREAGH, V.C., FEBRUARY 27TH, 1915. THE GENERAL IS PASSING ALONG THE FRONT OF "A" COMPANY, FOLLOWED BY COMMANDANT H. C. GUNTON (ON HIS RIGHT), AND THE COMPANY COMMANDER, D. H. KENNEDY.

Photo by Photopress



THE POST OFFICE ENGINEERING VOLUNTEER TRAINING CORPS.

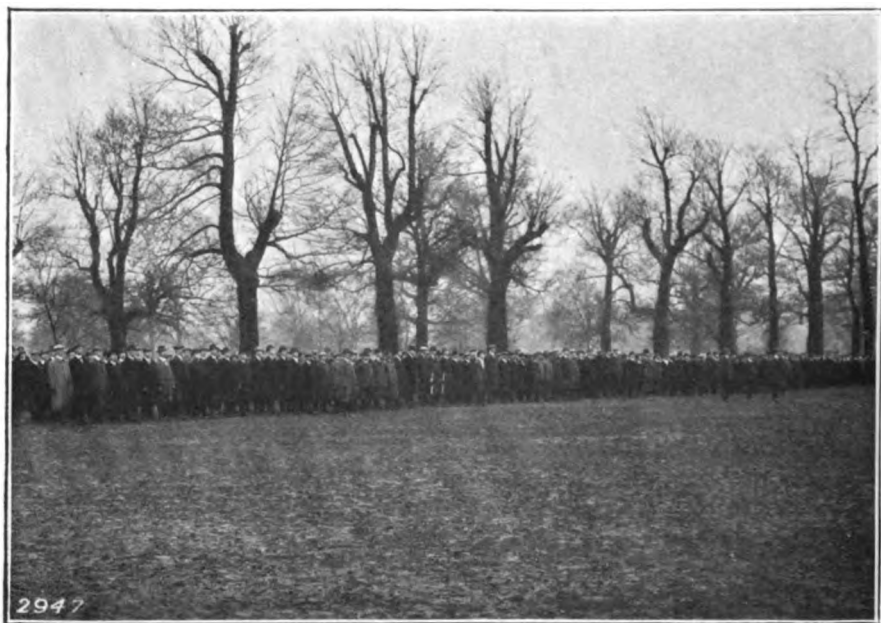
THE notion of organising Post Office men possessed of technical knowledge into an Emergency Corps of Engineers for Home Defence was a happy one. It was argued that as the Engineering Department has nothing to learn in the essentials of telegraphic and telephonic communication, it ought to be possible to cast the available technical knowledge into military form, and to produce in a short time a corps that might not only complete the volunteer organisation and be drawn upon by the War Office in the event of invasion, but that might at once train detachments of the younger men to be drafted to the regular army as soon as they could obtain leave from their official duties. The Corps has naturally been recruited mainly from the Engineering Department, but contains a fair number of men from the Stores Department, the Central Telegraph Office, and the London Telephone Service. Mr. Gunton, a former officer in the Royal Engineers (Territorials), is the Commandant and Mr. Preston the Adjutant. Mr. Stubbs, Mr. Noble, Mr. Moir, and Mr. Trezise are Second Commandants, and Mr. Kennedy, Mr. Watts, Mr. Greenham, Mr. L. B. Turner, Mr. Purves, and Mr. Shaughnessy are the Company Commanders of the six companies of which the Corps at present consists, while Mr. Parsons, of the Stores Department, acts as Quartermaster, and is in charge of the transport arrangements.

The Corps is affiliated to the Central Association of Volunteer Training Corps, and its formation and activities have from the outset been watched with favour and sympathetic interest not only by

TRAINING ENGINEERING VOLUNTEER TRAINING CORPS.

the Postmaster-General, the Secretary, and the Heads of Departments, but by General Sir O'Moore Creagh, who is the Military Adviser to the Central Association and Regimental Commandant of all the volunteer corps of the County of London.

Enrolment took place just before Christmas, and the Corps set to work immediately after. Within a few days the Commandant, aided by his senior officers, with initiative and energy that almost made one gasp, had obtained leave to use the old Inns of Court Hotel as Headquarters, to drill in Gray's Inn Square, to use the G.P.O. shooting range, to erect air-lines in Hyde Park and



INSPECTION DAY: A BIT OF THE LINE.

Kensington Gardens, to dig trenches on the site of G.P.O. East, and to borrow apparatus and tools from the Stores Department. So then, early in the New Year, the Corps, with a membership of 400 or 500, threw itself into the mysteries of squad drill, Swedish drill, musketry, route marches, and practical telegraph, air-line, cable, and field work. As many of the officers have both technical knowledge and military experience, the whole of the instruction has from the first been given from within the Corps. The means by which various individual members have acquired familiarity with martial ways are interesting and diverse, but best known to themselves. One at least admitted that he practised giving the words of command at home, and described how he induced his wife, the cook,

ENGINEERING VOLUNTEER TRAINING CORPS. **TRAINING**

and housemaid to "move to the right in fours" round the kitchen table. However, the great point is that in a few short weeks even those officers who previously did not know a file from a battalion have learned to handle their men correctly and confidently.

On Sunday, January 10th, the Corps had its first great field-day, proceeding in ten motor omnibuses and a few private motor-cars to Gerrard's Cross, where trenches were dug and an air-line was erected by special detachments under the personal direction of the Commandant, while the remainder of the troops were drilled by the



DETACHMENTS FROM "B" AND "E" COMPANIES AIR-LINE SECTIONS DISMANTLING AND WINDING-UP.

Adjutant. Since then hardly a Saturday or Sunday has passed without technical work being done in Hyde Park. There the activities of the Corps have attracted considerable attention and given rise to many inquiries as to who the men are and what they are doing. One member of the public, shortly after the telephone breakdown caused by recent gales, entered into conversation with a shivering strainer who was anxiously hanging on to a bay and a half of copper wire. Having had his curiosity satisfied he remarked ironically—"Oh! All Post Office men, are you? And you spend every Sunday fooling around here putting up wires and taking them down again, while my Exchange line has been broken for the last fortnight!"

TRAINING ENGINEERING VOLUNTEER TRAINING CORPS.

Occasionally the officers, in the belief that they ought to be personally acquainted with every detail of the work, have met secretly and erected an air-line themselves. The fact that their purpose was essentially serious did not prevent them from getting a good deal of amusement out of the proceedings. One could not but notice the uncanny way in which the jumper avoided the business part of the sledge-hammers wielded by two officers, who might be past masters at making a dry joint but whose strong point was plainly not navying. It was remarked also that the



A FIELD TELEPHONE SECTION. THE EQUIPMENT INCLUDES TWO COMBINATION TELEGRAPH-TELEPHONE SETS, CABLE DRUM, EARTH SPIKE, AND HEEL PLATES. THE LONG ROD IS USED TO RAISE CABLE AT ROAD CROSSINGS, ETC.

wire was never made more taut than by two other officers, who carry great weight in official (and other) circles, and who were giving their services as strainers; while the sight of Eye-Witness Present with General Headquarters, then Present also with a drum barrow containing 2 cwt. of wire, moved a brother officer to exclaim: "Look! here's Eye-Witness doing some work! I never thought I should live to see it!"

On one memorable occasion, the day of a competition between selected detachments from each of the six companies, one company at the critical moment managed to get lost in the wilds of Kensington Gardens. Scouts under the guidance of one of the second com-

mandants, well known for the usual mildness of his ways, were sent out in all directions. It is rumoured that a park-keeper, noticing this officer's anxious expression, said: "Wot's lost?" and was shocked at receiving the cryptic and uncensored reply, "Yes; and the whole B. Company with him!" That company was found eventually, and in spite of the failing light, ran an excellent air-line, finishing by moonlight at 7.15 p.m. This determination to carry the work through, notwithstanding adverse circumstances, is characteristic of the keenness and the general spirit of the Corps. It should be remembered that the field work has been done during the worst part of the year for training purposes, with short days, bad light, sometimes with snow on the ground and often in mist and rain and mud. There has been no hanging back or slacking on that account. On the contrary, one has often heard the men say when the weather conditions have been more than usually unpleasant: "This makes it more like the real thing." And the result so far has been very encouraging, and all the better for the fact that both officers and men have taken the work in a sporting spirit.

On February 27th, that is, only eight weeks after its formation, the Corps was inspected in Hyde Park by Gen. Sir O'Moore Creagh. After the men had been put through company and battalion drill, signalling headquarters were established near the Magazine, in Kensington Gardens, and two detachments erected air-lines, one across the Row to Marble Arch and the other across the Serpentine to Kensington Palace. Two other detachments laid field telephone lines, and lines of communication were also established by means of flag signallers. The General complimented the officers and men on the progress they had made, both in drill and in the technical work. He said he realised the amount of solid work that must have been performed to bring the Corps to its present standard of efficiency in so short a time, and expressed the hope that he would see them again, working as divisional troops in conjunction with other volunteer units. A few days after the Inspection notification arrived that the Corps has received "recognition" by the War Office, in token whereof the members will now be seen wearing the symbolic red brassard.

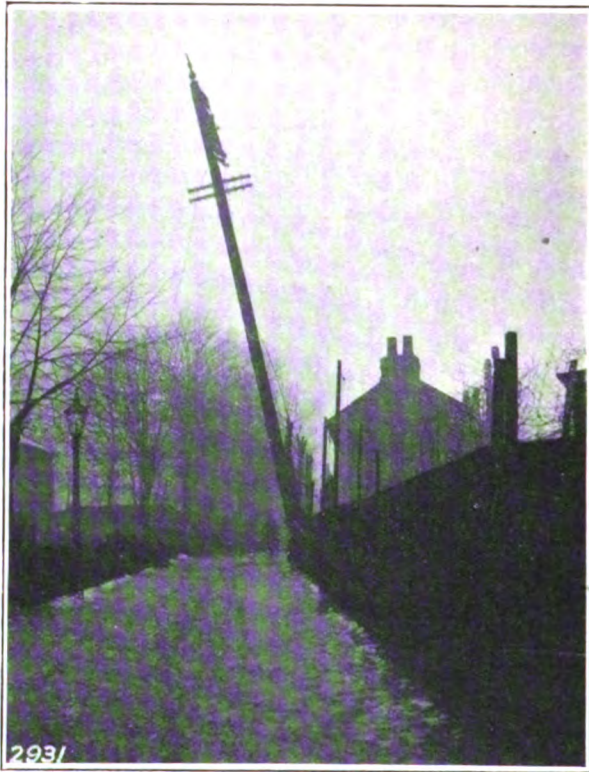
It is gratifying to record that the first detachment of young men has been formally handed over to the military authorities and accepted for active service in the Royal Engineers. Thus the Corps is already justifying its existence. Enrolment is still open to readers of this paper who are in sympathy with the aims and objects of the Corps and who feel that they could be of use. They will find in it enough hard work to absorb all their surplus energy and patriotism. Application for membership may be made personally to any of the officers or by letter to Mr. Preston, the Adjutant.

A. P.

SNOW-STORM DAMAGE IN LONDON.

By A. MOIR, M.I.E.E.

USUALLY free from the snow-storms which not infrequently cause serious damage to overhead-line plant in the provinces, London had its record of immunity from such visitations rudely



I.—50-FOOT POLE CARRYING 50 WIRES DEFLECTED BY SPAN OF WIRES BREAKING.
DAMAGE TO LIFE AND PROPERTY NARROWLY AVERTED.

broken on January 22nd last, when snow fell for nearly the whole day. The large, sticky flakes adhered to the wires as they fell. In the evening the temperature reached freezing-point, turning the snow into ice, with the result that even the slight wind which arose overnight was sufficient to extend seriously the destruction caused by the weight of snow. Some parts of North London escaped the snow-storm altogether, and the actual fall, north of the Thames, was in no case more than 2 in. in depth, the damage to overhead plant on the north side of the river being consequently quite insignificant. South of the Thames, however, a fall of snow, varying from 4 in. to

6 in., was registered, and the damage to telephone plant was much greater than anything which had been experienced in London during the past fifteen years.

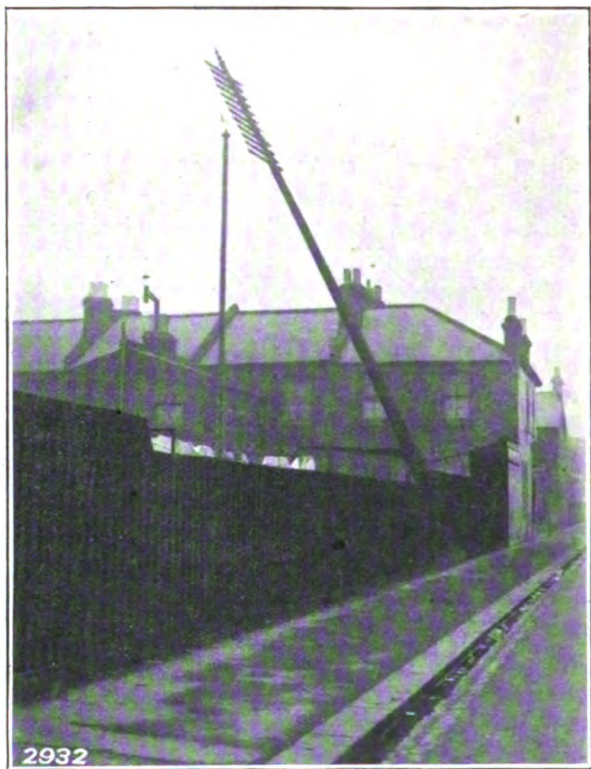
In the London telephone area 12,507 lines¹ were interrupted, of which 9,302 were within the London engineering district. The following figures indicate the extent to which some of the exchanges suffered :

	Total lines.	Lines out of order.	
Battersea	1935	1421	73 per cent.
Brixton	2685	1260	49 ..
Lee Green	1911	1020	53 ..
New Cross	1872	1047	56 ..
Streatham	2290	1284	56 ..
Sydenham	1994	1000	50 ..

An examination of the damaged lines—and there were few, if any, which escaped—revealed the usual features of a snow-storm breakdown. The conductors generally proved to be relatively weaker than the poles and stays, and the wire damage was therefore very great. Numerous stays were either drawn or broken, however, and a large number of poles were seriously deflected, although the number actually broken was small. Frequently, all the wires in the spans were entirely severed, and in other cases complete breakage was only saved because the wires, sagging much below their normal dip, were held up by the roofs of buildings. In one case, where the stays and conductors held, the pole, unable to resist the vertical pressure, buckled and broke, and, in similar circumstances, another pole standing in spongy soil was forced downwards into the ground several inches. Although the damage was general, light, as well as heavy lines, and even “drops” serving subscribers’ premises having been broken down, the greatest amount of damage occurred on the acquired heavy lines which stand on private property, and carry from 100 to 120 wires, and, in some cases, one or two aerial cables as well. Where the conductors on such lines were broken in successive spans, some time was saved in restoring communication by replacing the bronze wires with recovered aerial cables which had been repaired and kept in stock by the Contrcllor of Stores. These heavy overhead lines were provided by the National Telephone Company not so much from choice, perhaps, as from necessity, and although they have stood well, and will continue to do so under normal weather conditions, they are particularly liable to snow-storm damage. On private property wayleaves for poles and stays cannot always be obtained in the required positions. As a result, some stays which are really necessary have to be dispensed with, and others have to be fixed at incorrect angles, while wayleave difficulty also leads to the erection of spans of abnormal lengths.

Moreover, when a breakdown takes place, the workmen are seriously hampered in effecting renewals by the lack of adequate means of effecting repairs owing to restrictions imposed by property owners; and the time taken in running wires over buildings, and in erecting new poles in awkward positions, delays the restoration of the service.

Several days were occupied by the gangs in the preliminary work of getting poles and wires into safe positions in order to protect the



2.—DISPLACED 60-FOOT POLE CARRYING 94 WIRES.

public, and, after this had been done, the poles on the main lines had to be pulled up and re-stayed before the actual renewal of the subscribers' circuits could be taken in hand. Circuits were restored at the rate of 2500 per week.

By February 23rd the service was on the point of being wholly restored, but on that date, unfortunately, a second snow-storm visited London which dealt another blow to the overhead system, with the result that the number of faults was increased to 3,986 in the London district. The damage caused by the second storm extended over nearly all the exchange areas, but in this case very few poles were disturbed, the interruptions being caused mainly by

broken wires. 1792 faults were cleared within twenty-four hours, and in a week's time practically complete restoration of service was secured.

On January 22nd the thickness of ice on the 40-lb. wires varied from $\frac{3}{4}$ in. to $1\frac{1}{2}$ in. At a diameter of, say, 1 in. the calculated addition to the weight on one wire in a span of 100 yards would be 93 lb. The minimum breaking stress of 40-lb. bronze wire

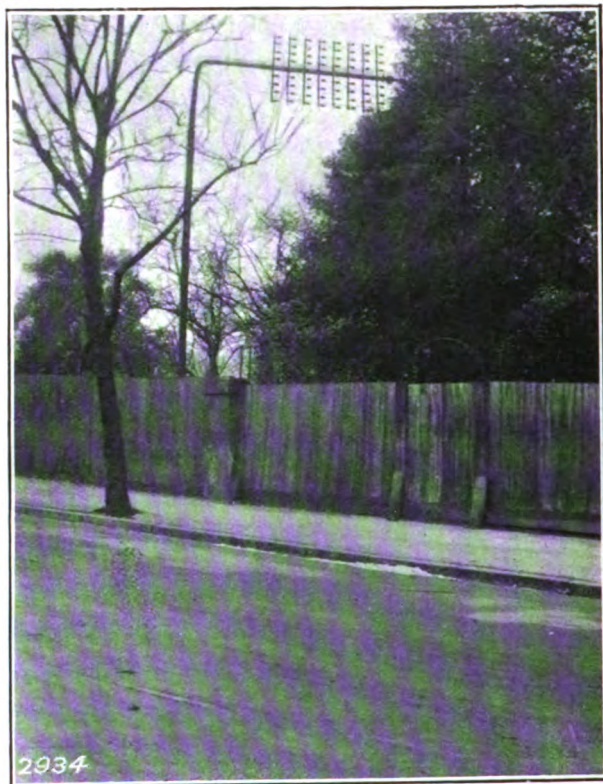


3.—DEFLECTED CROSS-ARM 60 FEET POLE WITH 102 WIRES.

is 197 lb., and in winter the stress for normal sag is about 28 lb. for 100 yards. The dead weight added to the structures would have been increased forty-fold and the surfaces exposed to wind pressure extended twenty times. It is, of course, well known that the smaller gauges of wire carry more snow in proportion to their size than the heavier gauges. Snow storms which prove very destructive to 40-lb. wire may do little damage to 100-lb. wire, while conductors of 150 lb. and more may be left almost intact. In the present instance the aerial cable routes did not suffer, notwithstanding the great surface exposed, as the "steels" which carry them were able to take the added snow loads without distress.

DAMAGE**SNOW-STORM DAMAGE IN LONDON.**

The two storms occurred at a most inopportune time, as 25 per cent. of the experienced wiremen—practically the whole of the margin available for emergencies—had joined the colours, and no help was available from provincial districts. The services of 117 Royal Engineers were obtained on loan from the War Office, and their assistance proved to be of great value. The supervising officers and workmen of the district brought much enthusiasm and energy



4.—DAMAGED IRON POLE (N.T. PATTERN) CARRYING 64 WIRES.

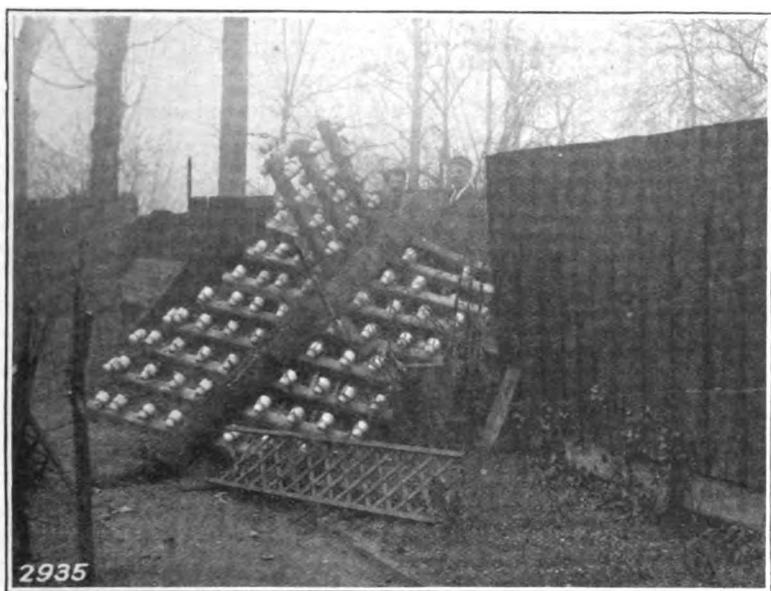
to bear upon the work of renewals. The following particulars give some indication of the extent of the damage done by the storm of January 22nd :

Wooden poles broken	.	.	21
Iron poles broken	.	.	7
Iron poles buckled	.	.	8
Roof standards broken	.	.	1
Poles deflected	.	.	998
Stays broken or drawn	.	.	230
Wire, 40-lb., erected	.	.	21 tons (1176 miles).
Wire, 100-lb., erected	.	.	6 cwt

Wire to be regulated . . .	2000 miles.
Roofs damaged . . .	410
Chimneys damaged . . .	216
Walls and fences damaged . . .	93

The recent snow-storms have taught few lessons which past experience had not already made known, but the following general comments should perhaps be placed on record:

(1) The present policy of diverting heavy overhead routes to underground cables, with which some progress has already been made in connection with development schemes, should be continued.



5.—HEAD BROKEN OFF 50-FOOT ANGLE POLE CARRYING 80 WIRES.

It is to be remembered, however, that the rate of progress is limited by the numbers of skilled workmen and the amount of money available in any given year, and by the consideration that preference has to be given to the provision of cables not already existing in areas where new subscribers are waiting, to diversions rendered compulsory by the withdrawal of wayleaves, and to exchange transfers required in order that sections of long-distance exchange lines may be made available for more profitable use.

(2) Where new open lines are decided upon they should be erected, where practical and economical, upon public streets or roads, and the number of wires should be kept strictly within limits.

(3) The practice of erecting wires on brackets attached to house

property should be forbidden, excepting for the actual connection to individual subscribers' premises, and, where it is possible to do so, the brackets should be fixed to the walls of the houses instead of to the chimney-stacks. The claims for repairing property damaged by the recent storms represent a high figure.

(4) In contrasting the relative cost of overhead and underground schemes, it is necessary to remember that an allowance has to be made, not only for storm damage costs, but for other economic factors. In connection with the January storm, 11,800 printed letters were issued to subscribers by the Controller of the London Telephone Service explaining that delay in restoration would take place, and a good deal of additional correspondence was thrown upon his office. Message-rate revenue from lines thrown idle will have been lost, and revenue lost because new lines could not be completed, as the engineering staff were engaged on storm repairs, should also be set against the storm damage. In addition, the Department's reputation for stable service, which by persistent effort has been much improved, cannot but have suffered, and the ordered and progressive work of the engineering district generally has been delayed and disorganised by the need for drawing a large number of men from their ordinary work and placing them upon storm repairs.



DUPLEX BAUDOT TESTS.

By MAJOR A. C. BOOTH, R.E.

IN order to ascertain the maximum amount of traffic that can be carried by the different types of Duplex Baudot, the Controller of the Central Telegraph Office, London, was good enough to arrange for two-day tests of the sextuple duplex to Birmingham, the quadruple duplex to Liverpool, and the recently erected quadruple duplex to Glasgow, which works through a duplex repeater at Warrington.

The idea of the tests was to ascertain the approximate value of such apparatus under emergency conditions, such as occurred at the C.T.O. in 1910. There was no intention to ascertain operator output, because that had been already tested over a considerable period. In 1910 the quadruple duplex to Birmingham carried as many as 600 messages in one hour; the quadruple duplex to Liverpool carried as many as 628 in one hour, thus confirming the figures obtained in 1910. The results on the Glasgow quadruple duplex were not so good, being only 446; but this set has been installed quite recently, and, owing to the war conditions, the messages are noticed to be considerably longer than those at Birmingham and Liverpool.

The sextuple duplex carried 849 messages in the hour, and was not even then at its best, as Birmingham sent 455 to London's 394. This difference was due to slight faults in the printing apparatus at Birmingham, and to a slight insufficiency of traffic. Under better conditions it is expected that the figure of 900 messages in the hour would have been exceeded.

The results obtained are most creditable to all concerned, and show the value not only of the Baudot as such, but also of the duplex method of working, which was so severely criticised before it had been tried, although it has since been adopted in the Murray multiplex. The Western Electric Company have also adopted the duplex method in their multiplex apparatus, which is now being tested in this country.

For record purposes and for the benefit of those readers desirous

TELEGRAPHS

DUPLEX BAUDOT TESTS.

of obtaining further details of the tests, the results are set out in the following tabular form :

LONDON—LIVERPOOL. QUADRUPLE DUPLEX BAUDOT.

February 8th, 1915.

Time.	No. 1 channel.		No. 2 channel.		No. 3 channel.		No. 4 channel.		Total.		
	S.	R.	S.	R.	S.	R.	S.	R.	S.	R.	Gross.
11 a.m. to noon.	66		58		76		75		275		} 569
		70		76		75		73		294	
Noon to 1 p.m.	69		63		72		64		268		} 554
		70		73		81		62		286	

February 10th, 1915.

11 a.m. to noon.	78		80		71		83		312		} 628
		72		80		86		78		316	
Noon to 1 p.m.	77		73		79		72		301		} 609
		69		76		83		80		308	

LONDON—GLASGOW. QUADRUPLE DUPLEX BAUDOT.

February 2nd, 1915.

Time.	No. 1 channel.		No. 2 channel.		No. 3 channel.		No. 4 channel.		Total.		
	S.	R.	S.	R.	S.	R.	S.	R.	S.	R.	Gross.
11 a.m. to noon.	56		55		53		60		224		} 439
		54		51		52		58		215	
Noon to 1 p.m.	56		53		55		58		222		} 444
		57		60		42		63		222	

February 3rd, 1915.

11 a.m. to noon.	60		54		58		65		237		} 446
		55		48		51		55		209	
Noon to 1 p.m.	59		50		53		59		221		} 407
		47		47		38		54		186	

LONDON—BIRMINGHAM. SEXTUPLE DUPLEX BAUDOT.

February 4th, 1915.

Time.	No. 1.		No. 2.		No. 3.		No. 4.		No. 5.		No. 6.		Total.		
	S.	R.	S.	R.	S.	R.	S.	R.	S.	R.	S.	R.	S.	R.	Gross.
11 a.m. to noon.	72		70		67		63		74		60		406		827
		75		77		66		73		70		60		421	
Noon to 1 p.m.	71		60		70		58		63		63		385		682
		53		51		45		51		37		60		297	

February 5th, 1915.

11 a.m. to noon.	69		77		64		64		59		61		394		849
		85		82		68		80		67		73		455	
Noon to 1 p.m.	71		65		66		67		65		69		404		706
		72		55		14		63		48		50		302	

Excellent as the results are, there are two other important features in favour of the system, viz., a very appreciable decrease in the delay on the work passing over this system as compared with other types, the rapid correction of errors, and the fact that the skilled sending is very easily learned and is preferred to Morse or typewriter working. Correct sending at thirty words per minute has been learned in a week; the outside time required is less than two months.

The above tests were made at a working speed of thirty words per minute per channel, which is the generally accepted rate of working. With the introduction of alphabetical keyboard perforators and automatic transmitters the speed can be readily raised to forty, forty-five, or even fifty words per minute. Even with the ordinary 5-key Baudot keyboard a speed of forty-five words per minute has been maintained without any error for some minutes. We may, therefore, yet be able to see the skilled telegraphist holding his own with the very much more costly keyboard perforator and automatic transmitter.

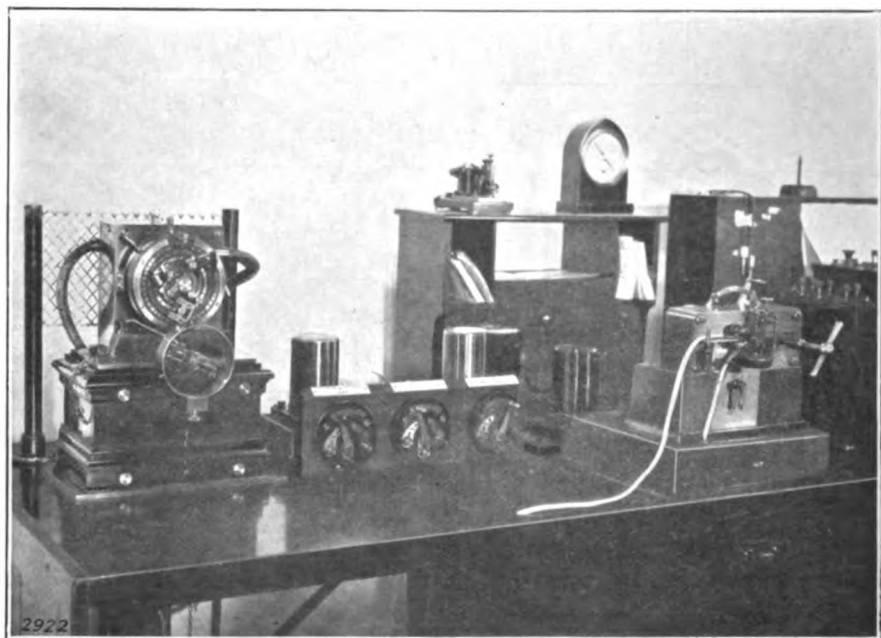
As an instance of the reliability of Baudot duplex working on long lines the following consecutive daily results obtained on the recently installed London to Glasgow circuit of some 400 miles in length, with a duplex repeater at Warrington, are worth recording.

TELEGRAPHS

DUPLEX BAUDOT TESTS.

LONDON TO GLASGOW.

February		Sent.		Received.		Total.
1	.	1784	.	1217	.	3001
2	.	1885	.	1539	.	3424
3	.	1950	.	1564	.	3514
4	.	1645	.	1310	.	2955
5	.	1845	.	1409	.	3254
6	.	1491	.	1137	.	2628
8	.	1690	.	1380	.	3070



BAUDOT DISTRIBUTOR, QUADRUPLE DUPLEX: IN THE C.T.O., ON THE LONDON—LIVERPOOL CIRCUIT.

9	.	1773	.	1362	.	3135
10	.	1846	.	1407	.	3253
11	.	1895	.	1503	.	3398
12	.	1905	.	1514	.	3419
13	.	1562	.	1258	.	2820

The figures are not so good as those on similar quadruple duplex Baudot sets on the shorter circuits to Birmingham and Liverpool. This is not due to the greater length of the circuit, but to the facts already mentioned, longer messages and less experienced staff. There is, however, not much room for an increase in the general reliability and uniformly good working, but there is no question

that the amount of work dealt with will increase with longer experience.

It will be interesting to compare these results with similar tests on other systems of large output. At present I think the 849 on the sextuple duplex is easily a world's record, because the messages were finished and disposed of, whereas in a Wheatstone system, where a far greater number of messages can be transmitted, they are very far from being finished with, and generally a second circuit is required for clearing up the corrections, etc.

As a matter of interest, a photograph of the distributor table at London on the Liverpool circuit is shown. The arrangement of the apparatus has now been standardised for all types of duplex, viz., double, triple, quadruple, and sextuple for one distributor, and another arrangement with two distributors for such circuits as combined double or triple duplex used for long cable circuits, or for the combined quadruple or sextuple sets which may be required to work either as a sextuple or as a quadruple on a more difficult line.

Two notable instances of the double distributor sets are: (1) the London—Birmingham combined sextuple and quadruple duplex, and (2) the London—Antwerp combined triple and double duplex. The first equipment was amply justified; in the early days considerable opposition attributed all difficulties to the sextuple, but an immediate change to quadruple generally proved that the trouble was not due to the sextuple arrangement. The second equipment was completed only a short time before war broke out, and was arranged because of the variability and frequent changes of the land lines between London and Antwerp. It did excellent work until the fall of Antwerp, sometimes as triple in both directions, at others as triple in one direction and double in the other, when difficulty arose with the balance at one station.

The line to Antwerp was not an easy one, as it consisted of some eighty miles of aerial line on either side of some sixty miles of submarine cable, thus rendering the duplex balance subject to considerable variation during weather changes. Hence the experience gained should be of use to those who erroneously believe that the Baudot duplex is suitable only for stable underground lines. The fact that six double duplex Baudot sets worked well on the lines from London to Hamburg and Berlin through some 300 miles of submarine cable and 450 miles of aerial line, with two duplex repeaters involving six duplex balances to each circuit, is ample proof that the Baudot duplex is quite as suitable as any other duplex system for difficult aerial line working.



312

“NOTHING NEW UNDER THE SUN!”

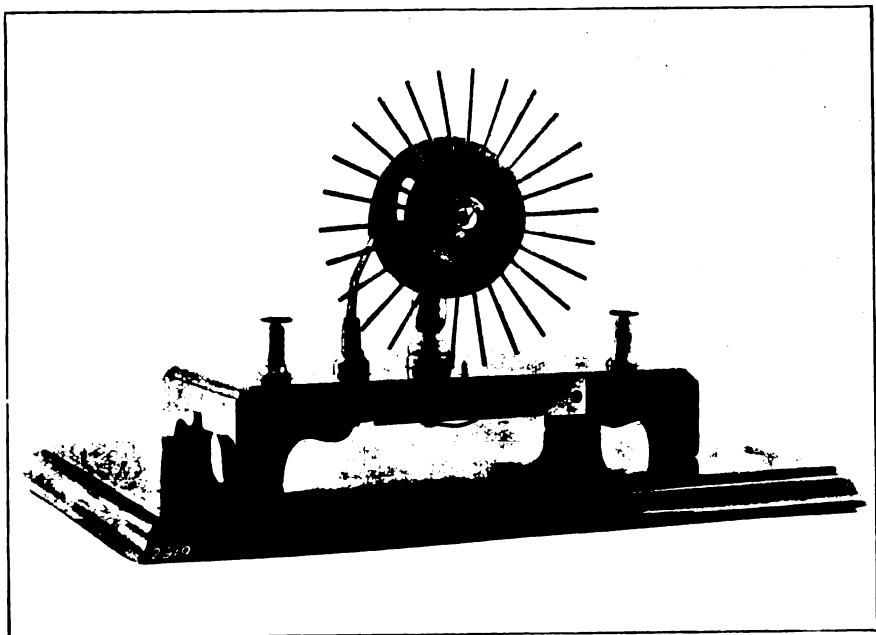
AMONG the many ingenious devices developed in connection with automatic telephony the impulse-sending mechanism which forms part of each subscriber's station holds an essential place. Much care and skill have gone to the perfecting of this important part of the automatic system, and, among various competing types of impulse-senders, the well-known Strowger “Dial Switch” has long been recognised to bear the palm for sweet simplicity of design and manipulation. The happy thought which called into being a plain rotating dial furnished with finger-holds to represent the numerals, and arranged to transmit the number of impulses corresponding to each by the simple act of placing the finger in any numbered position and pulling the dial round to a fixed finger stop, has powerfully aided the Strowger system in the attainment of its present widespread popularity. The master patent which secured the monopoly of this device was lodged in the United States in 1897 and was granted in England as Patent No. 809 of 1898. During the life of this patent the designers of other automatic systems were compelled to devise alternative types of impulse controllers for the subscribers' stations, some of which were very complex and expensive, while others were obviously attempts to approach the Strowger dial switch as closely as the terms of the patent would allow. The main claims of the patent may be set out as follows: “In a calling device for automatic telephones, the combination, with a series of pivotally arranged finger holds and of a finger-stop adjacent thereto, of a current making and breaking device common to all of the finger-holds, such making and breaking device being adapted to operate a series of electro-magnets in harmony with the finger-holds.”

Litigation on the subject, and threatenings of litigation, there have been in plenty, and since the patent expired, in 1912, more than one leading competitor has adopted a frank copy of the Strowger

dial, which now promises to become in its essentials the universal type for automatic telephones.

And all the while this has been going on no one had given a thought to an old telegraph transmitter invented by Wheatstone in 1839, and patented by Messrs. Cooke and Wheatstone in that year, which would have been capable, if produced in Court, of knocking the bottom out of all these claims.

A long-forgotten specimen came to light in a recent clear-out of some old store cupboards at the General Post Office, and, in the



I.

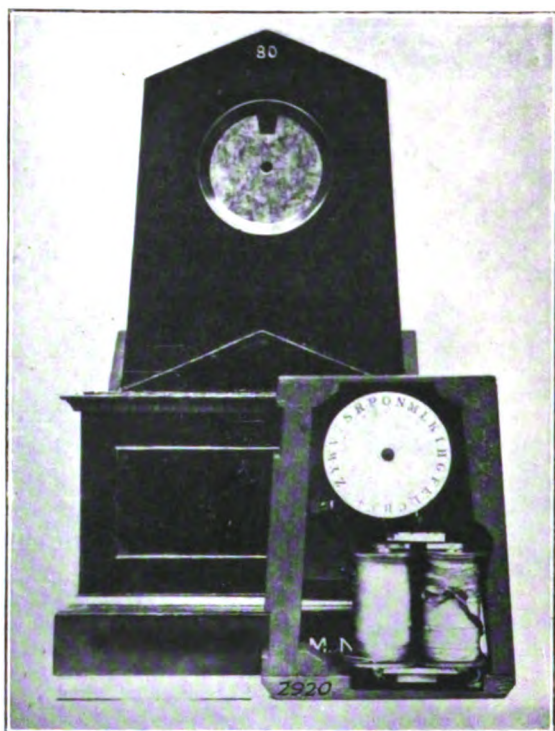
glory of fresh lacquer and glazed mahogany case, has now been added, as item 644, to the Engineer-in-Chief's museum collection.

A photograph of this interesting historical relic is shown in I. Its kinship to the automatic dial switch "leaps to the eyes." The "pivotaly arranged finger-holds" are there in the form of radial spokes, each corresponding to a character on the lettered periphery of the dial; the "finger-stop adjacent thereto" is there in the form of a short brass pin fixed in the base below the centre of the dial; the "current making and breaking device common to all of the finger-holds" is there in the form of a contact spring sliding over alternate insulating and conducting segments on the rim; and the purpose of the whole was "to operate a series of electro-magnets in harmony with the finger-holds."

TELEPHONES "NOTHING NEW UNDER THE SUN."

The function of the instrument as a step by step telegraph transmitter is so obvious that no explanation is required. It was worked in association with a hand switch, which, in one position, introduced the transmitter, and a sending battery in series with it, into the circuit, and in the other position introduced the receiving instrument.

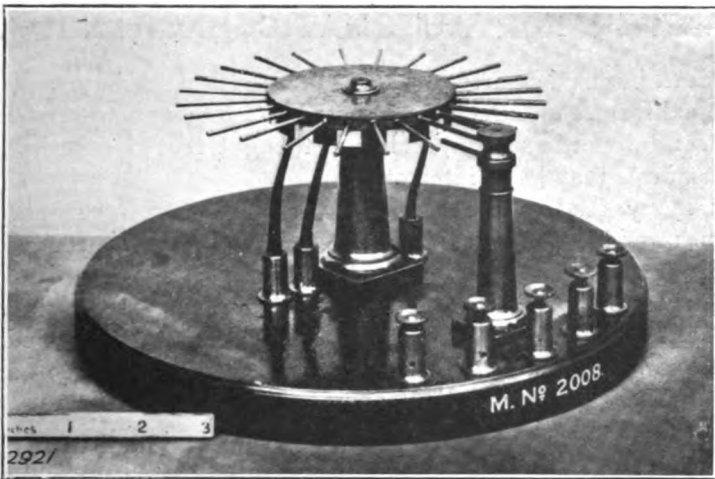
I have managed to secure a photograph, 2, of one of the latter, which is preserved in the South Kensington Museum. The working



2.

parts, which are shown removed from the case, comprise an electro-magnet actuating a propelling pawl and ratchet, which serve to rotate a cardboard disc bearing the letters of the alphabet. This disc is mounted behind a blank brass face having a single small aperture through which one letter at a time can be seen. Before commencing a message the dial of the transmitter and the lettered disc of the receiver are set to zero. With each operation of the transmitter dial the receiver disc is correspondingly stepped forward, and so exposes the letters successively to view until the one which is being signalled stops in front of the aperture and is read off by the receiving tele-

graphist. A later form was driven by a clockwork train, and the axis of the disc carried an escapement wheel; pallets fixed to an armature vibrating between the poles of two electro-magnets permitted the disc to progress one tooth or step for each current. One circuit on which such instruments are known to have been used was on the Great Western Railway between Paddington and Slough. There is no reason to doubt that they provided quite an efficient and reliable means of low-speed communication, but as telegraphic requirements grew they had, of course, to give place to systems of higher traffic carrying capacity. Nevertheless, there was a time, about twenty-five years ago, just before the popular advent of the telephone,



3.

when the need for a simple telegraph instrument, requiring practically no skill to operate or to adjust, was experienced in connection with short private wires carrying only a few messages per day, and in this connection the revival of instruments of this early type, had it been thought of, might have been worth serious consideration.

The receiving instrument in the South Kensington collection is accompanied by a transmitter, 3, which shows a slight development as compared with 1. The receiving disc and the transmitter dial both carry numerals and other signs in addition to letters. The dial in this case is horizontal, and, in addition to the battery and the make and break contact springs, which are arranged to disconnect the transmitter when the dial is turned to zero, there is a third spring which, in the zero position, automatically puts the line to earth, or through to its "down" side, *via* the receiving instrument, in readiness to receive a message. In later forms the axis of the dial

TELEPHONES SUBSCRIBER'S STATION COIN BOX.

was provided with a spur wheel geared in the ratio of 13 to 1, with a pinion whose axis carried a double coil electro-magnet revolving close to the poles of a large compound horse-shoe magnet, and so generating a magneto electric current impulse for each half revolution of the pinion, and dispensing with the use of a battery. From this the well-known Post Office form of Wheatstone "ABC," which did so much good service for many years, was gradually developed.

T. F. PURVES.

SUBSCRIBER'S STATION COIN BOX AND CALL METER FOR AUTOMATIC EXCHANGES.

A COIN box and a party-line sub-station call meter have now been developed for use on circuits connected to exchanges worked on the Strowger automatic system, and it is thought that a description of the apparatus may be of interest.

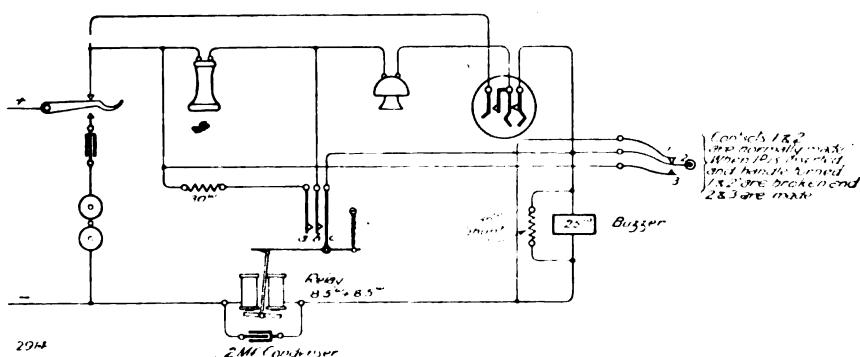
As many readers are already aware, the Strowger automatic system provides for a reversal in the direction of the current supplied to a subscriber's line when that line is being used for calling up another subscriber on the same exchange. This reversal is brought about when the ringing is cut off the circuit of the called subscriber in consequence of his removing his receiver to answer. The back-bridge relay is then operated, and its armatures reverse the battery connections to the calling line.

This reversal is made use of in the coin box and the call meter by the introduction of a low resistance polarised relay placed in series with the subscriber's transmitter and receiver. The relay may be regarded as a 2-position electro-magnetic switch, operating certain contacts which control the caller's circuit in such a way as to enforce the payment of the calling fee, or registration of the call, as the case may be. The control takes the form of short-circuiting the caller's transmitter and shunting his receiver with a 30^m resistance; release being obtained by mechanical means brought into play when the calling fee is deposited in the coin box, or the call registered on the meter. No reversal takes place when a line is used to call up the exchange for information, or for trunk or junction service. The two last-mentioned services are catered for by the provision of a buzzer in the coin box; an exchange record of trunk and junction calls is kept in respect of circuits fitted with sub-station call meters. Having dealt with the broad outlines of the scheme, we will now proceed to consider each piece of apparatus in detail.

COIN BOX.—The coin box consists of the Department's standard coin collecting box, No. 1A, with the addition of the necessary relay

and contacts, condenser and releasing gear. This additional apparatus is fitted in the space beneath the wooden bridge-piece.

I is a diagram of a subscriber's circuit with a coin box installed. The connections are shown as they would be during an incoming call or prior to the reversal of an outgoing call. Under these conditions the circuit is from switch-hook through receiver, transmitter, dial-switch, contacts 1 and 2 (short-circuiting buzzer) and 17th polarised relay with condenser in parallel, to line. The relay armature is held over, as shown in the diagram, but the shaft attached to the armature is not exerting any pull on the floating spring mounted on the long vertical spring "c." The reversal of the battery connections throws the polarised relay over to the opposite position, and the shaft picks up the floating spring and pulls it over



I.—SUBSCRIBER'S TELEPHONE WITH COIN BOX. CIRCUIT CONNECTIONS.

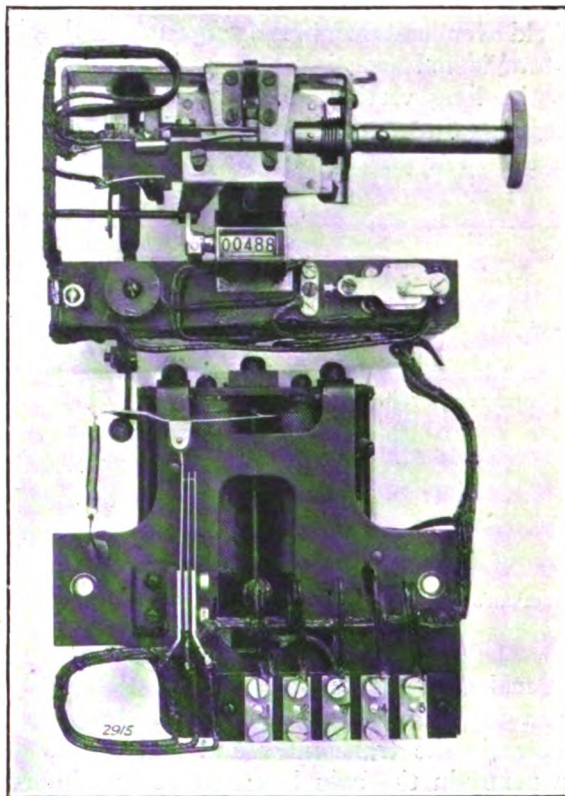
far enough to make the contacts of the springs *a*, *b*, and *c*. Contacts *a* and *b* place a 30th shunt across the receiver terminals, contacts *b* and *c* short-circuit the transmitter and dial-switch. The act of depositing a penny in the coin box operates a trip arm which disengages the floating spring from the shaft; it then returns to its normal position and the three contacts are broken.

The contacts 1, 2, and 3 on the right of the diagram are controlled by the coin mechanism. When the handle of the box is turned to deposit a coin the long spring, No. 2, is depressed and breaks contact with No. 1, and makes on No. 3. The break between contacts 1 and 2 removes the short across the buzzer, which is then actuated. The closing of contacts 2 and 3 short-circuits the receiver (also transmitter and dial-switch), so that the buzzer cannot be heard in the subscriber's receiver. Normal speaking conditions are restored when the coin box handle is released after depositing a coin.

A caller using a coin box station dials for the required number in

TELEPHONES SUBSCRIBER'S STATION COIN BOX.

the usual way and listens for an answer. If a reply is not received for any reason the caller naturally does not pay. If an answer is received conversation on the part of the caller is impossible owing to the short across the transmitter. The 30^{w} shunt across the receiver does not prevent the caller from hearing the answering subscriber, but serves as a precautionary measure to forestall attempts to use the receiver as a transmitter. It will be apparent, from

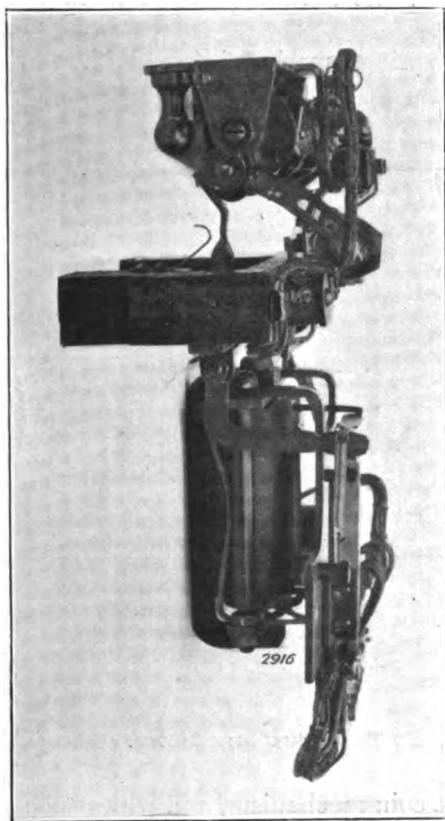


2.—AUTOMATIC COIN BOX MECHANISM WITH COVER REMOVED. FRONT VIEW.

what has been stated above, that incoming calls to a coin box station are not subject to charge. It will contribute largely to the satisfactory working of the system if the subscribers cultivate the good habit of giving their name and number when answering a call.

Before leaving **I** it will be well to mention that the object of placing the condenser across the terminals of the 17^{w} polarised relay is to limit the degrading effect of the relay winding on the transmission. With the condenser in circuit, the loss, as compared with an ordinary subscriber's circuit, is 0.6 miles of standard cable, as against 2.27 m.s.c. without the condenser.

2 and 3 show respectively front and side views of the apparatus. The condenser is omitted in each case for the sake of convenience. 2 shows the general arrangement. The contact springs marked *a*, *b*, and *c* in 1 can be seen mounted on the left of the front plate, behind which is the relay. The relay is a standard magneto-bell movement wound to $8\cdot5^w + 8\cdot5^w$. The hammer shaft is bent



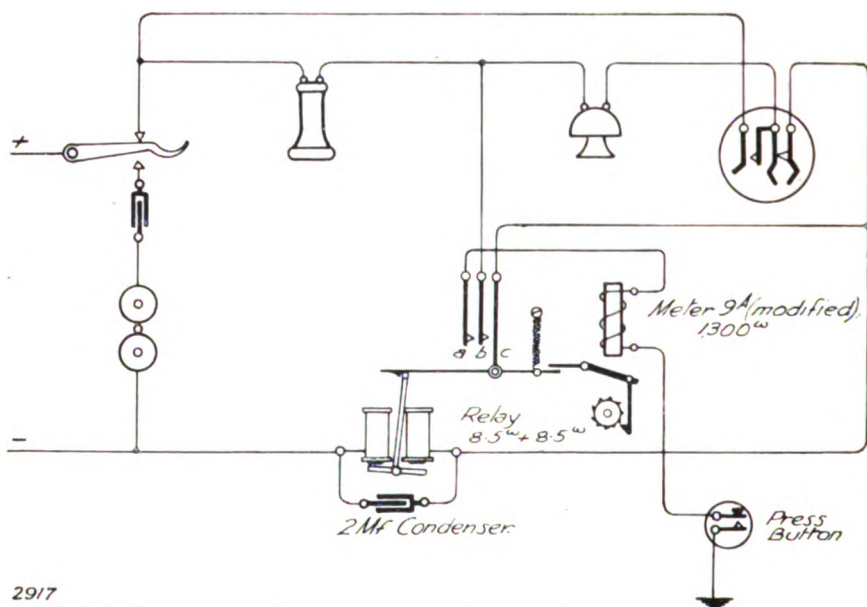
3.—AUTOMATIC COIN BOX MECHANISM WITH COVER REMOVED. SIDE VIEW.

forward and projects across the floating spring immediately behind the projecting tongue on the latter. When the shaft is moved over to the right, in unison with the movement of the armature, it engages with the projecting tongue on the floating spring and carries the spring with it, thus causing the long vertical spring, to which the floating spring is pivoted, to bend over and make contact with the two adjacent springs. The trip arm can be seen projecting under the left hand end of the floating spring. A more detailed view is shown in 3. It will be observed that the arm is pivoted below the wood block, and that its upper end rests against a wheel on the

TELEPHONES SUBSCRIBER'S STATION COIN BOX.

veeder arm. The veeder arm imparts a backward and downward movement to the upper end of the trip arm, and the lower end is consequently thrown forward and upward and tilts the floating spring clear of the shaft. The spring is at once restored to its normal position under the influence of the vertical springs, and the contacts are broken. The bias spring on the relay armature restores the shaft to its normal position when the conversation is finished.

The contact springs marked 1, 2, and 3 in **1** are mounted below



29/7

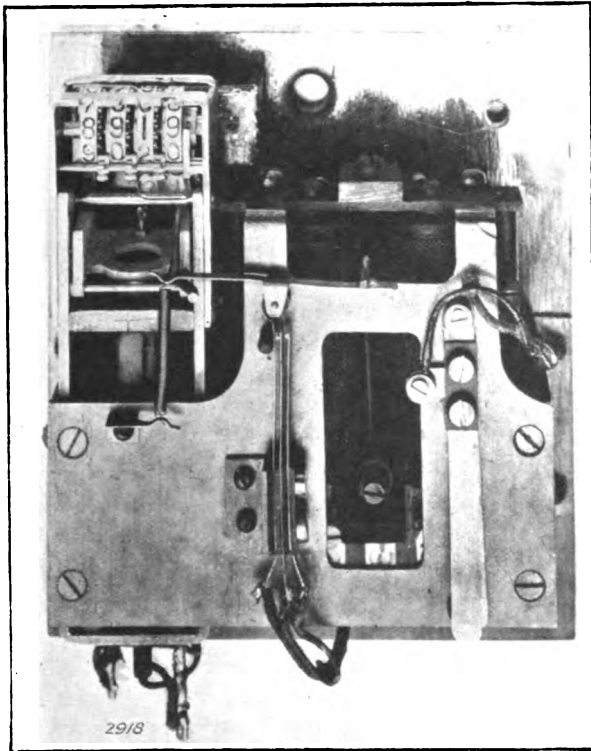
4.—SUBSCRIBER'S TELEPHONE WITH METER. CIRCUIT CONNECTIONS.

the spindle of the coin mechanism, and will not be referred to in any greater detail, as they are already familiar as part of the standard coin box.

The coin box described is designed for use in places where the fee for an originating local call is 1d. Calls other than local calls are handled by an operator; the buzzer provides a means for checking the payment of the extra fee for such services. It would have been possible to arrange that the buzzer operated only when required to enable an operator to check payment, but the disadvantages attendant upon the necessary additional apparatus were considered as outweighing any advantage in the scheme.

CALL METER.—4 is a diagram of a subscriber's circuit with call meter installed. The connections are shown as they would be throughout an incoming call or prior to the reversal on an outgoing

call. The polarised relay operates as already described in the case of the coin box. The contacts *a*, *b*, and *c*, when closed, short-circuit the caller's transmitter and dial-switch, and connect one side of the register winding to line, the other side being earthed through a press-button. The caller dials for the required number in the usual way and presses the button when he hears the reply. The meter is then operated, and the movement of its armature is made to release the



5.—SUBSCRIBER'S METER MECHANISM, WITH COVER REMOVED.

floating spring and break the contacts *a*, *b*, and *c*. It will be seen that the meter can be operated only once per originating local call, and that it is inoperable except at the proper time.

5 is a photograph of a workshop model and gives a general idea of the apparatus. The relay and the arrangement of the contacts are exactly as described for the coin box. The register is the standard subscriber's register for Strowger Automatic Exchanges, with the addition of a control spring on the armature to ensure reliable working in the vertical position. A cranked pin is screwed into the armature to serve the same purpose as the trip-arm already described.

The meter is designed for mounting on a wall in the vertical

TELEPHONES NEW YORK TO SAN FRANCISCO LINE.

position, with the meter dials uppermost, and must not be used in any other position. It was originally intended to have a press-key fitted on the meter, but this plan was abandoned in favour of a separate press-button, as the meter cannot always be fitted conveniently near the telephone instrument. The meter is provided with a detachable metal cover secured by means of a lead seal.

J. H. WATKINS.

THE NEW YORK TO SAN FRANCISCO TELEPHONE LINE.

THE long-projected trans-continental telephone line has at length been completed. New York and San Francisco have now direct telephonic communication over an aerial line nearly 3400 miles long. The opening ceremony took place on January 26th last. On that occasion the above line was linked with other important American circuits, the most distant point reached being Jekyl Island, an extension of 1000 miles from New York. Conversations were exchanged between President Wilson at Washington and Prof. Graham Bell (the well-known inventor of the telephone) in New York. The President also conversed with San Francisco, 3600 miles distant, and congratulated all concerned. Mr. Theo N. Vail, President of the American Telegraph and Telephone Co., conducted a conversation from Jekyl Island to San Francisco, and Mr. J. J. Carty, under whose principal direction the line has been designed, participated in the tests. Many other American notables also took part. Speech is said to have been clear and sufficient. Prof. Graham Bell also conversed with Mr. Watson (his assistant at the time of the invention of the telephone) in San Francisco, by means of a duplicate of his original telephone. Although, of course, many improvements have been effected since the invention, it is interesting to note that Mr. Watson understood what was said.

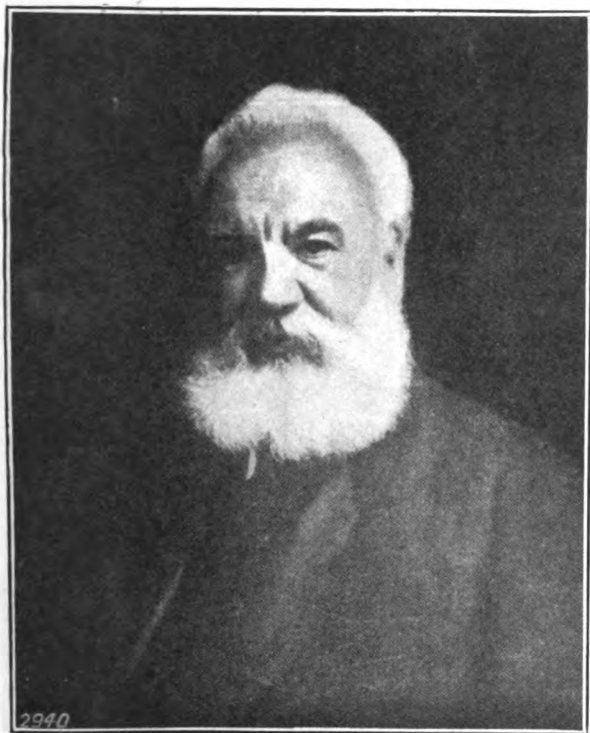
"It appeals to the imagination to speak across the Continent," remarked President Wilson, during his conversation referred to above, and this is an apt description of the state of mind produced by the event. Congratulatory speeches were made during the ceremony, and the American Telegraph and Telephone Co.'s chiefs improved the occasion by placing on record the phenomenal progress the Company has made since the telephone was invented.

There are two loaded circuits between New York and San Francisco, the copper conductors of which weigh 435 lb. per mile per wire (.165 in. diameter), and on these wires a third loaded circuit is superimposed or "phantomed." There are not more than ten

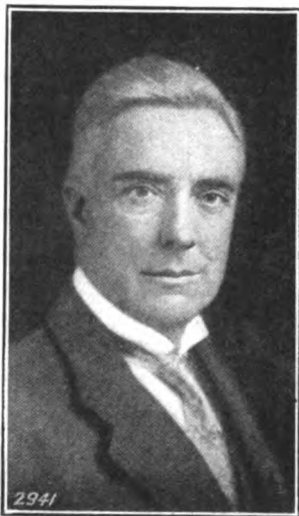
NEW YORK TO SAN FRANCISCO LINE. **TELEPHONES**

miles of underground cable in the whole length. Provision has been made for sending several telegraph messages simultaneously over various parts of the line.

Speech travels over the entire 3400 miles of circuit in $\frac{1}{15}$ th second, whereas the average train time is ninety hours. The rate for public conversation between New York and San Francisco is \$20.70 (£4 6s. 3d.) for three minutes' conversation. It is pointed out, however, that about \$2,000,000 worth of plant will be utilised



PROF. A. GRAHAM BELL.



MR. A. WATSON.

during the conversation ; on the other hand, there are three telephone circuits, to say nothing of the telegraph channels.

The foregoing details are taken from the following journals :

'New York Telephone Review' and Special Edition Supplement to vol. vi, No. 1, January, 1915 ; 'Telephony,' January 30th, 1915. Abstract of article in 'Electrical World' in the 'Electrician' of February 26th, 1915.

The New York to San Francisco circuit is far longer than any other existing one, and the achievement is a remarkable one. The question naturally arises : How is it done ? It fortunately happens that although such achievements excite our wonder, yet the advance

TELEPHONES NEW YORK TO SAN FRANCISCO LINE.

of knowledge has quite removed them from the realm of the mysterious. The possibilities of speech over any circuit are limited by its electrical constants, its length, and the efficiency of the apparatus (including telephone relays) used in connection with it, an efficient standard of maintenance being assumed as an indispensable condition. From details already published we may obtain some idea of the possibilities of the circuit. In a paper read by Mr. Bancroft Gherardi, of the American Telegraph and Telephone Co., before the American Institute of Electrical Engineers (see the 'Electrician' of August 25th, 1911), a graph is given which shows the transmission equivalent of a No. 8 (435 lb. copper per mile)



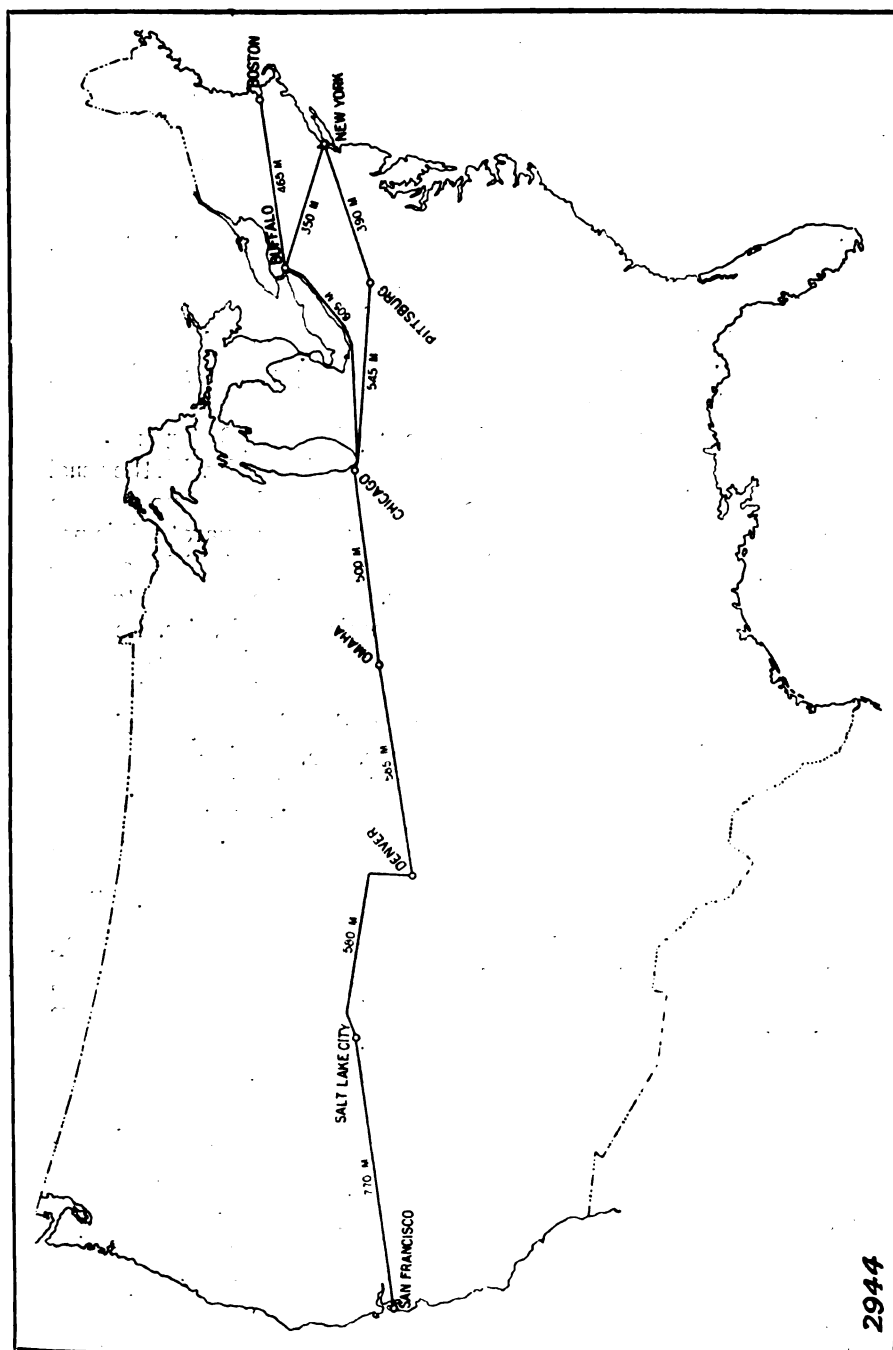
MR. J. J. CARTY, CHIEF ENGINEER.



MR. THEO. N. VAIL, PRESIDENT.
AMERICAN TELEGRAPH AND TELEPHONE COMPANY.

aërial circuit, loaded and unloaded. These circuits are similar to the new transcontinental ones. As nearly as can be read from the graph, the deduced attenuation constant, excluding end losses for the loaded circuit (not phantom), is 0.00155, and for the unloaded circuit 0.00365. The addition of "phantom" coils to this circuit would add resistance to it and slightly increase the attenuation constant; the net result appears to be that the range of speech over this particular circuit would be a little more than doubled by loading. Again, Prof. Fleming, in a paper on 'Improvements in Long Distance Telephony,' read before the Royal Society on March 27th, 1914, gave the electrical constants per mile loop of these circuits, on the authority of Mr. J. J. Carty; they are (unloaded) resistance (R) = 4.14 ohms, capacity (K) = 0.0091, mf., inductance (L) = .0034; the leakance (S) is not stated. The loading coils have

NEW YORK TO SAN FRANCISCO LINE. TELEPHONES



THE NEW YORK TO SAN FRANCISCO TELEPHONE LINE. MAP OF THE ROUTE.

2944

TELEPHONES NEW YORK TO SAN FRANCISCO LINE

an inductance of 0.265 henry and a resistance of 6.5 ohms at 800 periods per second. The attenuation constant quoted by Prof. Fleming is, however, 0.0013, and this would require a very high insulation if it refers to the side or physical circuits. The constants of the phantom circuit are not given, but from a statement of Mr. Carty at the Paris Conference of Telegraph Engineers in 1910, this circuit may be expected to be appreciably more efficient than the physical or side circuits.

Accepting 0.0013 as the best figure obtainable in the circuit combination in question we find that the standard cable value between New York and San Francisco is 41 miles. This does not include underground lengths, or end losses. (The standard cable has a resistance of 88 ohms and a capacity of 0.054 mf. per mile.) At the 1910 Paris Conference already referred to, it was recorded that an attenuation length amounting to " βl " = 4.8 (45 miles of standard cable) represents the practical limit of speech with the usual apparatus. This is, however, purely arbitrary, and to some extent a matter of opinion, especially as the term "usual apparatus" is not defined. It also does not take into account the possibilities of telephone relays or loud-speaking apparatus. Still, we are able to form some idea of the possibilities of the circuit from it, *i.e.* its total attenuation must closely approach what many engineers regard as the practical speech limit. The nearer we are to the limit the more difficult it is to maintain a continuous and satisfactory service on open lines, owing to the effects of weather, etc. This applies more especially to phantom circuits with superimposed telegraphs. The importance of telephone relays for such a line is obvious, and the possibility of one or more being used must be borne in mind; both 2-wire and 4-wire systems are known. In conditions favourable to their use they would materially improve speech in this circuit.

The transcontinental circuit has been rendered possible by coil-loading (the method introduced by Prof. Pupin). It is well known, however, that the efficiency of loaded circuits varies much more with insulation changes than unloaded ones do. The variation of the attenuation constant is approximately proportional to $R + \frac{SL}{K}$, where these letters have the meaning previously given. The inductance L is greatly increased by loading, and consequently the value of the expression changes more with variation of S . In a leaky line the increase in attenuation may be very serious. Every precaution is, of course, taken to guard against this as far as possible.

How, then, does the American line compare with the longest loaded European line? The longest loaded European circuit appears to be the Berlin to Rome line, 2082 kilometres in length. Prof. Fleming gives its electrical constants in the paper previously

referred to. Its conductors weigh 500 lbs. each per mile (4·5 mm. diameter), and the loading coils used have the same resistance per henry as the American ones. Its capacity and inductance are very nearly the same as the New York to San Francisco loaded side circuit, *i.e.*, they are: Capacity = 0·009 mf. per mile, inductance = 0·0354 henry per mile against 0·0091 mf. and 0·0365 henry in the American circuit: but the attenuation constant of the Berlin to Rome circuit is greater, *viz.*, it is 0·00177 per mile against 0·00155 for the corresponding American unphantomed circuit. This can only be on account of the former having a greater leakance, as, on account of its greater weight, its constants (excluding leakance) are, on the whole, such as to give a lower constant per unit length than the American circuit. Much, then, depends on the leakance, and incidentally on climate, but it is precisely on this point that sufficient data are not available, and particularly information showing over what portion of the year any assumed insulation can be maintained. In the absence of such information, comparisons must be made with caution.

In any case, however, the success which attended the opening ceremony of the transcontinental telephone line stamps the new line as a most notable achievement, and it shows in a marked manner the progress which has been made in long-distance telephony. All concerned are to be congratulated upon it.

J. G. H.

A STUDY OF TELEPHONE TRAFFIC PROBLEMS WITH THE AID OF THE PRINCIPLES OF PROBABILITY.

By W. H. GRINSTED, A.M.I.E.E., of Messrs. SIEMENS BROTHERS
& Co., LTD.

Note.—Recent published references to my work on this subject have resulted in a number of inquiries, particularly for the original paper of 1907. For this reason I have thought it might be of interest to give this study practically in its original form, reserving the developments which have been made since that date for a future paper. The following, therefore, is the paper of 1907 slightly abridged.

(I) INTRODUCTION.

(A) *Uses of the Theory of Probability applied to Telephone Traffic.*

Although telephone traffic may vary in a fairly definite way at different hours, the variations of one moment from the next cannot

be predicted at all. The former variation is due to general causes, such as hours of business, etc., the latter to unrelated causes, or, in other words, "pure chance." During one minute there may be not a single call on an operator's position; during the next there may be half a dozen.

In considering the number of operators, amount of apparatus, etc., necessary to handle the traffic efficiently it is clear that it would be uneconomical to provide for handling the greatest possible of these rushes without delay. The question is, What are the chances that the traffic at any time will exceed our provision for it? The theory of probability concerns itself with the measurement of chances in such cases as this, and its special application to telephony can be discussed under the headings:

(i) *The Number of Lines required to carry a given Traffic.*—The reason for placing this first is because the investigation of this problem is simpler and more direct than that of the others. The question at issue is, of course, the relation between the traffic, the duration of the calls, the number of junctions to be provided, and the chances of congestion occurring.

(ii) *Operating.*—Under this heading come the subjects of the relation between time of answer and operator's load, the effect of team work, the effect of shortening the time spent in actually operating a call, the effect of split order wires and the comparison of the operators' loads permissible in different systems, for example, in the ordinary multiple and the call distributing system.

(iii) *Errors.*—The question in this case is: How nearly do the results of a certain number of observations taken at random represent the true average of the whole series of results, and how much is the deviation from this average likely to be? This applies, of course, to other subjects than telephony, but in the latter, owing to the large number of cases which can be considered, the theory of errors is more directly applicable and its results are more reliable.

(B) *Previous Work.*

As far as I know, nothing has previously been done in this subject on this side of the Atlantic. Mr. Rorty, in America, has applied a somewhat intricate theorem of Laplace, giving the probability of (small) deviations from the mean, to the problems of telephone traffic, but the theorem is strained in the application being made to cover cases for which the assumptions in the mathematical analysis do not hold good.

(c) *Present Study.*

The remainder of the present paper is concerned with the

subject under the first heading only, namely, the number of lines required to carry a given traffic.

Throughout I have used reasoning from first principles as much as possible, together with one or two very elementary principles of the theory of probability.

(2) JUNCTION TRAFFIC.

(A) *Statement of Problem.*—The problem is: How many lines must be provided to carry a given number of calls of given duration, allowing a reasonable chance of each call getting through without delay? Or more generally: What is the relation between (1) number of junctions; (2) number of calls; (3) duration of calls; (4) probability of the answer “no lines”? Suppose all calls to be of the average duration. If more calls occur during an interval equal to the duration than we have junctions, they cannot all be put through. What is the likelihood of this occurring?

Further, supposing this state of congestion to occur sometimes, as it must do, what is the average probability of a call getting through?

(B) *Misleading Formulæ.*—One formula that has been suggested is: $L = \frac{M}{1 + \frac{C}{J}}$. (For explanation of symbols see appendix.) The

proof of this needs not only the assumption that the load on each junction is the same, but also a further false assumption that the chances of getting through with two junctions are double what they are with one.

Another is: $L = \frac{M}{(1 + C)^J}$. This is more correct theoretically,

but it still requires the assumption that the load is equally distributed among the junctions, and so cannot be applied to practical cases.

The derivations of these formulæ are given in the appendix. I have inserted them in order to point out where they fail.

(C) *Probability that the Number of Calls occurring during a Fraction of a given Period will exceed a certain Number.*—The probability of congestion is the probability that the number of calls during an interval equal to the average duration exceeds the number of junctions. Suppose eight calls, each of three minutes' duration, occur during three minutes, and we have only seven junctions; then the eighth call cannot be put through.

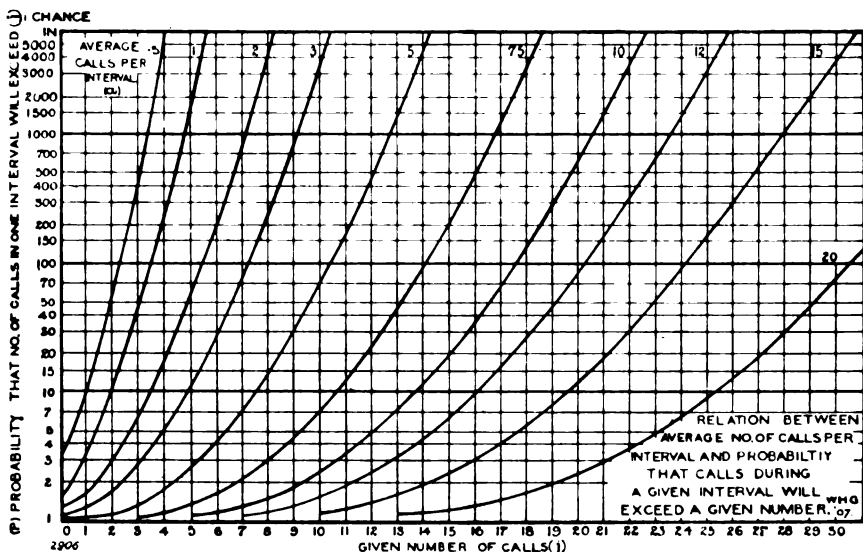
If we can obtain an expression for this probability, we can fix the number of junctions for a given traffic at such a number as to give any required degree of probability that congestion will not occur.

In the appendix it is shown that if “ n ” calls occur during a certain period, the probability that the number of calls occurring during any “ i th” part of that period will be exactly “ j ” is given by:

$$Q_j = \frac{1}{e^a} \cdot \frac{a^j}{j!} \text{ where } (a = \frac{n}{m} \text{ or the } (j+1)\text{th term of the series:}$$

$$\frac{1}{e^a} \left(1 + a + \frac{a^2}{2} + \frac{a^3}{3!} + \frac{a^4}{4!} + \dots \text{ to } \infty \right)$$

This is the well-known “exponential series,” the sum of all the



I.

terms (to infinity) being $\frac{1}{e^a}$. $e^a = 1$. That is, the sum of the probabilities for all numbers of calls is 1 or “certainty,” as we should expect.

The probability that the number of calls occurring during any i th part will exceed “ j ” is, of course, the sum of the probabilities that there will be $j+1$, or $j+2$, or $j+3$, etc., calls during the interval; that is:

$$\frac{1}{e^a} \left(\frac{a^{j+1}}{(j+1)!} + \frac{a^{j+2}}{(j+2)!} + \frac{a^{j+3}}{(j+3)!} + \dots \text{ to } \infty \right)$$

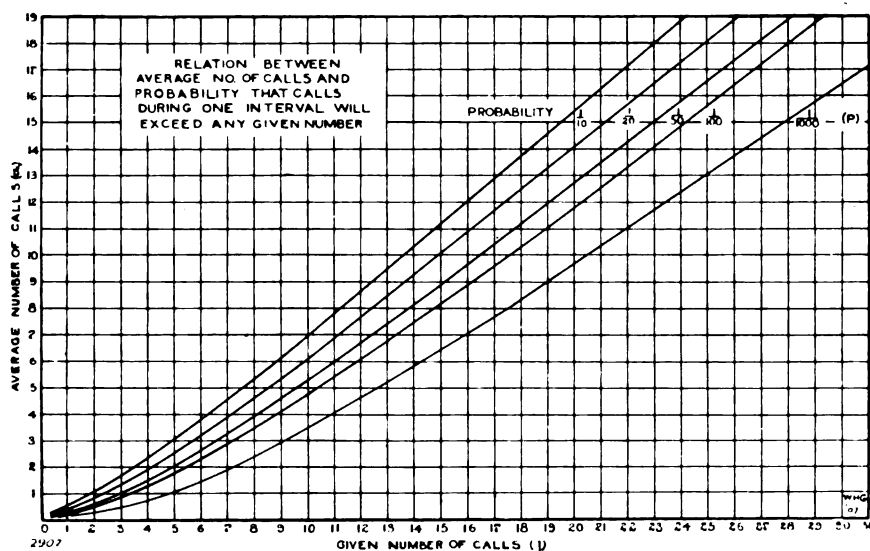
For example, suppose we have 100 calls per hour, of the average duration three minutes, and nine junctions to carry them. Then

$$n = 100, m = \frac{60}{3} = 20, a = \frac{n}{m} = 5, i = 9.$$

The probability of congestion occurring is,

$$\frac{1}{e^5} \left(\frac{5^{10}}{10} + \frac{5^{11}}{11} + \frac{5^{12}}{12} + \dots \text{to } \infty \right).$$

The terms decrease rapidly, and the sum of the series is, accurately enough, 0.0321. The probability of any three minutes' interval being congested is, therefore, 0.0321, that is, there are 321 chances in 10,000, or, roughly, 1 in 30, that more than nine calls will originate during one interval of three minutes. Or, *on an average*, one three minutes' interval out of thirty, *i.e.* one in one and a half hours will be congested.



2.

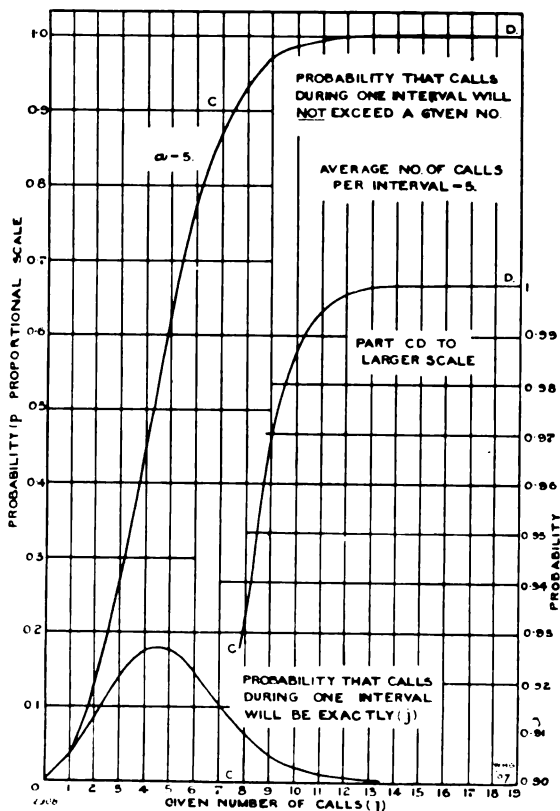
In 1 a series of curves is shown giving the probability that the number of calls during any interval will exceed any given number for different "call densities," *i.e.* different values of $a = \frac{n}{m}$, on the basis of the above formula. (The quantity represented by the ordinate is really the logarithm of the reciprocal of the probability. The object of plotting the curves in this way is to obtain the same degree of accuracy for all parts of the curve). To take one example, suppose we have 220 calls per hour, average duration two and three-quarter minutes, how many junctions must be provided to give one chance in 100 of congestion occurring?

We have $m = \frac{60}{2.75} = 21.8$; $\frac{n}{m} = \frac{220}{21.8} = 10$ nearly. Reading

the curve $\frac{n}{m} = 10$ for a probability period of $\frac{1}{100}$, we must have 17.6, *i. e.* eighteen junctions.

In 2 the same quantities have been plotted in a different way. These curves show the relation between the traffic and the number of lines that must be provided to obtain a definite probability.

Suppose we wish to reduce the chances of congestion in the example above to 1 in 1,000, how many junctions must we provide?



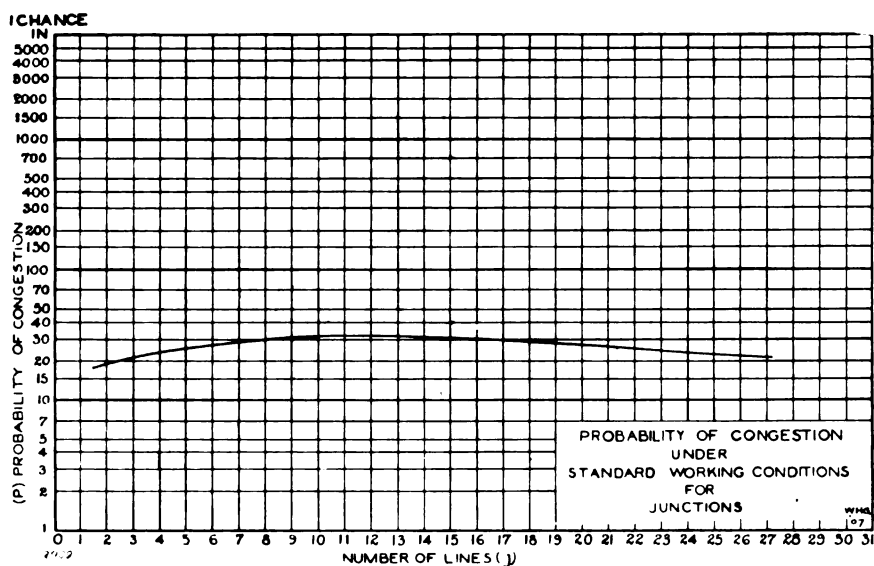
3.

Reading the $\frac{1}{1000}$ curves, $\frac{n}{m} = 10$, we must have 20.6 or 21 junctions.

3 gives one example (for $a = \frac{n}{m} = 5$) of the same quantities plotted to a proportional scale. On the same sheet a curve is given showing the probability that the calls during one interval will be exactly equal to the given number. As we should expect, the number of calls most likely is the average number ($a = \frac{n}{m}$), in this case 5.

(D) *Application to Working Curves.*—How do these theoretical results fit the curves in practical use for determining the number of lines required to deal with a given traffic? About what chances are we taking in practice?

Junction Traffic Curve.—In 4 the probability corresponding to normal practice (as represented by the curves in 5) is plotted. This is obtained in this way from 5 :—200 3-minute, or 220 2·75-minute, or 240 2·5-minute calls require 15·7 junctions and $\frac{n}{m}$ for each of these cases = 10 ($= 200 \times \frac{3}{60} = 220 \times \frac{2\cdot75}{60} = 240 \times \frac{2\cdot5}{60}$).



4.

So the point corresponding to normal practice on the curve for $\frac{n}{m} = 10$ (1) is that having the abscissa 15·7.

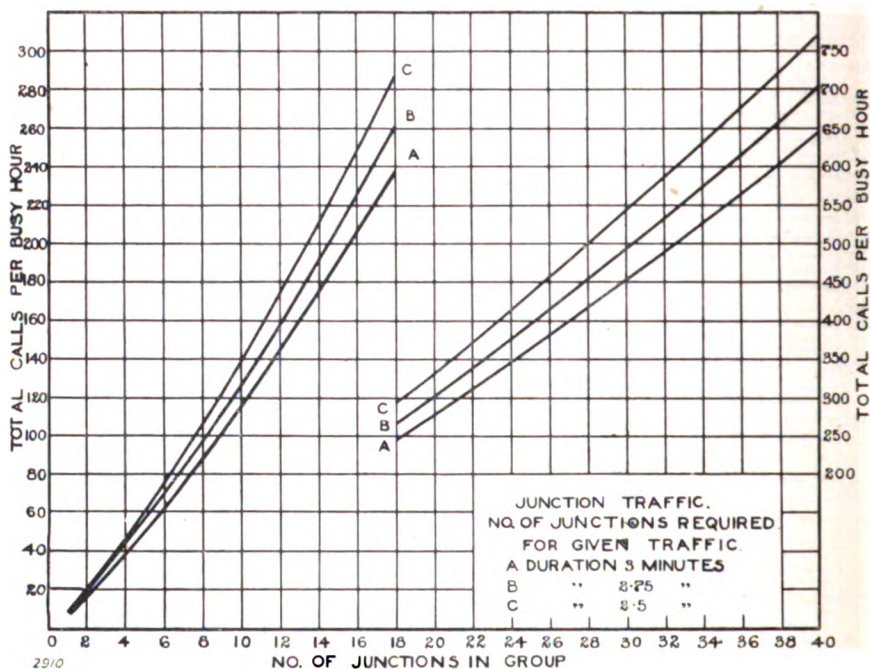
It will be seen that the ordinates of all these points are very nearly equal, and correspond approximately to a probability of $\frac{1}{30}$.

The agreement between the value for the probability in different cases shows that the theory gives workable results which are confirmed by practice. Further, in normal practice the chances of congestion occurring are 1 in 30, so that for junction traffic we may say that a probability of $\frac{1}{30}$ gives a satisfactory service.

(E) *Probability of any Call not getting through.*—So far only the probability of congestion occurring has been considered, *i. e.* the

probability that the reply "no line" will be given one or more times during any duration interval. What is the average risk of any call getting this reply, or, in other words, when a subscriber makes a call what are the chances that he will not get through?

If out of a large number (V) of calls a number (U) do not get through, the average probability of any call not getting through is $\frac{U}{V}$. In the appendix this principle is applied to extend the previous



5.

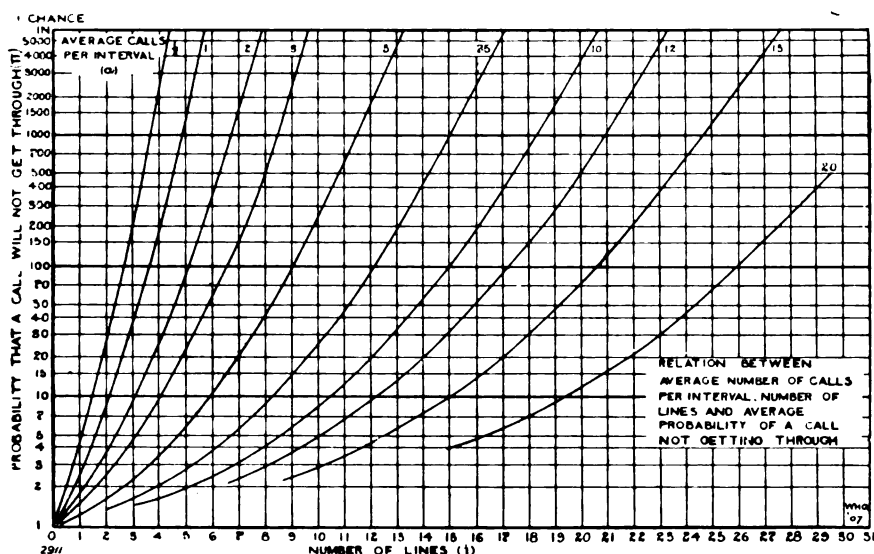
work to find the probability of any call not getting through owing to all the junctions being engaged.

The results are plotted as curves in 6 and 7.

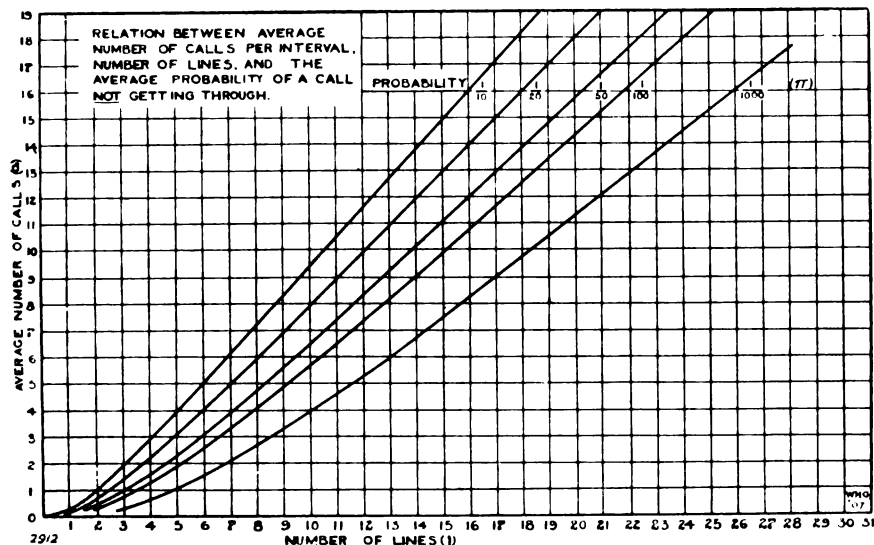
The conditions corresponding to practice are plotted in 8. It will be seen that the likelihood of a call getting the reply "no line" decreases with increase in the size of the group of junctions, down to about one chance in 160 for twenty junctions where it remains constant. It seems only fair that a better service should be provided on large groups than on small, as the traffic on the larger groups is probably more important.

(F) *General Relations and Conclusions.*—The relations traced above do not differ greatly from what one would expect; the results present no very striking features. The study serves to put one's ideas on a

sound basis, and *the* important result is that it reduces more or less vague notions to definite figures. It shows exactly how much more



6.



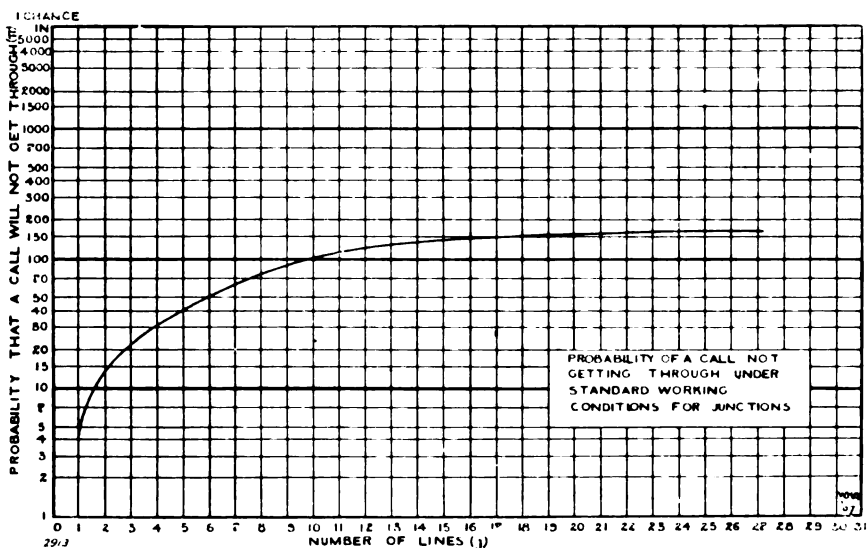
7.

efficient a group of four junctions is than a group of three, it tells us that we are running an average risk of 1 in 30 of getting congestions. It shows just how many more junctions we must provide to reduce this risk to 1 in 60. Once we have settled the probability

we are prepared to accept in any case, it provides the means of designing the plant to give that probability.

With regard to the value of the probability under working conditions the figures $\frac{1}{30}$ for congestion and $\frac{1}{150}$ for any call not getting through on junctions seem to represent the conditions under which we are working.

There are, of course, many disturbing influences in actual practice which will modify these values; for example, the varying durations of the calls and the "selective" effect due to operators



8.

waiting their turn on the call-wire and so preventing the calls reaching the "B" operators completely "at random," etc. But I believe that the average risks are represented quite accurately enough for practical purposes by the figures given.

(3) APPENDIX.

(A) *Literature*.—This subject does not appear to be touched on in any of the telephone text-books, nor is any treatment which is directly applicable to be found in mathematical works, as far as I know. For the elementary mathematical principles the following books are useful:

Whitworth's 'Choice and Chance.'

De Morgan's 'Essay on Probabilities.'

(B) *Definitions*.—Throughout the words "probability" and "chances" have been used with the following meanings:

In a series of N events, having different results A, B, C —, if a is the number of results A , and b the number of results B , etc., the probability of a result A is $\frac{a}{N}$, of a result B $\frac{b}{N}$, etc., where N is very large.

Another way of speaking is: there are a chances in N or 1 chance in $\frac{N}{a}$ that the result will be A .

If there are only two results, A and B , then we can say it is a chances to b or $\frac{a}{b}$ to 1 that the result will be A .

Thus, if the probability of a certain result is $\frac{2}{5}$ the chances that it will arrive are 2 in 5 or 2 to 3 for it, or, in general terms, if p is the probability $\frac{p}{1-p}$ are the chances for the result.

The probability that it will not happen is, of course, $1 - p$.

(c) *Derivation of Misleading Formula.*—Let L be load per junction, *i.e.* number of calls per hour.

M , the number of times the duration is contained in one hour, *i.e.* maximum number of calls one line can carry.

C , chances of getting through.

J , number of junctions in group.

$$(1) L = \frac{M}{1 + \frac{C}{J}}.$$

Consider one junction. Ratio of disengaged time to engaged time = $\frac{M - L}{L}$. Therefore, chances of getting through on one junction are $\frac{M - L}{L}$ to L , or $\frac{M - L}{L}$ to 1, and by making the false assumption that the chances with J junctions are J times the chances with one, we get

$$C = J \times \frac{M - L}{L},$$

which reduces to

$$L = \frac{M}{1 + \frac{C}{J}}.$$

$$(2) L = \frac{M}{(1 + C)^{\frac{1}{J}}}$$

Consider one junction. Probability of finding it engaged is ratio engaged time to total time = $P = \frac{L}{M}$. If P is the probability of a certain result

in one case, P^n is the probability of the same result in all of n cases. Hence probability of finding all J junctions engaged = $\left(\frac{L}{M}\right)^J$ or

$1 - \left(\frac{L}{M}\right)^J$ against it.

$$C = \text{chances of getting through} = \frac{1 - \left(\frac{L}{M}\right)^J}{\left(\frac{L}{M}\right)^J}$$

$$= \left(\frac{M}{L}\right)^J - 1.$$

$$L = \frac{M}{(1 + C)^{1/J}}.$$

(D) *Probability that the Number of Calls occurring during a Fraction of a given Period will equal a Certain Number.*—Let the average number of calls in an interval equal to " $\frac{1}{m}$ " th of the period be " $\frac{n}{m}$ ", that is, the total number of calls during the period is " n ."

Suppose the period divided into N parts where N is so great that no part contains more than one call.

Then there are n parts with calls and $N - n$ without. An interval contains $\frac{N}{m}$ parts. The problem is then, in $\frac{N}{m}$ parts what is the probability of there being a given number (j) of one kind, namely, with calls?

The probability of a part with a call is $\frac{n}{N}$.

" " without a call is $\frac{N - n}{N}$.

Then the probability of an interval with j calls is given by the $(j + 1)$ th term in the expansion of the binomial $\left\{\left(1 - \frac{n}{N}\right) + \frac{n}{N}\right\}^{\frac{N}{m}}$

$$\begin{aligned} \left\{\left(1 - \frac{n}{N}\right) + \frac{n}{N}\right\}^{\frac{N}{m}} &= \left(1 - \frac{n}{N}\right)^{\frac{N}{m}} + \frac{N}{m} \left(1 - \frac{n}{N}\right)^{\frac{N}{m}-1} \frac{n}{N} + \frac{N(N-1)}{m^2} \left(1 - \frac{n}{N}\right)^{\frac{N}{m}-2} \left(\frac{n}{N}\right)^2 \\ &\quad + \dots \\ &= \left\{\left(1 - \frac{n}{N}\right)^{\frac{N}{m}}\right\}^{\frac{n}{m}} + \frac{n}{m} \left\{\left(1 - \frac{n}{N}\right)^{\frac{N}{m}}\right\}^{\frac{n}{m}} \left(1 - \frac{n}{N}\right)^{-1} + \\ &\quad \frac{n^2}{m^2} \cdot \frac{1}{2} \left\{\left(1 - \frac{n}{N}\right)^{\frac{N}{m}}\right\}^{\frac{n}{m}} \frac{N(N-m)}{N^2} \left(1 - \frac{n}{N}\right)^{-2} \\ &\quad + \dots \end{aligned}$$

If N is very large indeed,

then $Lt \left(\frac{N}{n} = \infty \right) \left(1 - \frac{1}{N} \right)^{\frac{N}{n}} = e^{-1}$ (by the exponential theorem)

and m and n are negligible compared with N . Hence, probability $Q_j = (j + 1)$ th term in the series

$$\begin{aligned} & e^{-\frac{n}{m}} + \frac{n}{m} e^{-\frac{n}{m}} + \frac{n^2}{m^2} \cdot \frac{1}{2} \cdot e^{-\frac{n}{m}} + \dots \\ &= e^{-\frac{n}{m}} \left\{ 1 + \frac{n}{m} + \frac{n^2}{m^2} \cdot \frac{1}{2} + \frac{n^3}{m^3} \cdot \frac{1}{3} + \dots \right\} \\ & \text{i. e. } Q_j = e^{-\frac{n}{m}} \cdot \left(\frac{n}{m} \right)^j \cdot \frac{1}{j!}, \end{aligned}$$

or writing " a " for $\frac{n}{m}$ (= the average calls per interval).

$$Q_j = a^j \cdot \frac{1}{j!} \cdot e^{-a}.$$

Note.—My attention has since been drawn to the derivation of the same formula in 'Das Gesetz der Kleinen Zahlen' of Dr. L. von Bortkewitsch.

(E) *Average Probability of any Call getting through.*—Consider a large number of intervals, N , so large that Np can be regarded as a whole number.

Probability of an interval having " j " calls is—

$$Q_j = (j + 1)\text{th term of } e^{-a} \times \left(1 + a + \frac{a^2}{2} + \dots \right)$$

There will be $\frac{N}{e^a}$ intervals with 0 calls; i. e. 0 calls.

„ „ $\frac{N}{e^a}$ „ „ 1 „ ; i. e. $\frac{N}{e^a}$ „

„ „ $\frac{a^2 N}{2 \cdot e^a}$ „ „ 2 „ ; i. e. $2 \cdot \frac{a^2 N}{2 \cdot e^a}$ „

„ „ $\frac{a^r N}{r! \cdot e^a}$ „ „ r „ ; i. e. $r \cdot \frac{a^r N}{r! \cdot e^a}$ „

So total number of calls—

$$\begin{aligned} &= a \cdot \frac{N}{e^a} \left\{ 1 + a + \frac{a^2}{2} + \dots + \frac{a^{r-1}}{r-1} + \dots \text{to } \infty \right\} \\ &= a \cdot \frac{N}{e^a} \times e^a = a \cdot N. \end{aligned}$$

This is, the average calls per interval multiplied by the number of intervals, as it should be.

Now, if the number of calls in any one interval is j or less than j (j = no. of junctions), they will all be put through. If more than j calls occur, only j will be put through.

So the calls put through will be—

For intervals with 0 calls	.	.	0
" " 1 "	.	.	$a \cdot \frac{N}{e^a}$
" " 2 "	.	.	$2 \cdot \frac{a^2}{2!} \cdot \frac{N}{e^a}$
" " etc.,			
" " $j-1$ calls	.	.	$j-1 \cdot \frac{a^{j-1}}{(j-1)!} \cdot \frac{N}{e^a}$
" " j "	.	.	$j \cdot \frac{a^j}{j!} \cdot \frac{N}{e^a}$
" " $j+1$ "	.	.	$j \cdot \frac{a^{j+1}}{(j+1)!} \cdot \frac{N}{e^a}$
" " $j+2$ "	.	.	$j \cdot \frac{a^{j+2}}{(j+2)!} \cdot \frac{N}{e^a}$
etc.			

Total number of calls put through—

$$\begin{aligned}
 &= \frac{N}{e^a} \left\{ a(1 + a + \frac{a^2}{2!} + \frac{a^3}{3!} + \dots + \frac{a^{j-1}}{(j-1)!}) \right. \\
 &\quad \left. + j \left(\frac{a^{j+1}}{(j+1)!} + \frac{a^{j+2}}{(j+2)!} + \dots \right) \right\} \\
 &= \frac{N}{e^a} \left[a \left\{ e^a - \left(\frac{a^j}{j!} + \frac{a^{j+1}}{(j+1)!} + \frac{a^{j+2}}{(j+2)!} + \dots \right) \right\} \right. \\
 &\quad \left. + j \left(\frac{a^{j+1}}{(j+1)!} + \frac{a^{j+2}}{(j+2)!} + \dots \right) \right]
 \end{aligned}$$

$\frac{1}{e^a} \left(\frac{a^j}{j!} + \frac{a^{j+1}}{(j+1)!} + \dots \right)$ = probability that calls during one interval will exceed $j - 1$ = (say) P_{j-1} .

$$\text{Total calls put through} = N \left\{ a(1 - P_{j-1}) + jP_j \right\}.$$

$$\text{Probability of getting through} = \frac{(\text{calls put through})}{\text{Total calls}}.$$

$$= 1 - P_{j-1} + \frac{j}{a} P_j,$$

and probability of call not getting through—

$$= \pi = P_{j-1} - \frac{j}{a} P_j.$$



THE REGULATION OF PLANT SUPPLY.

By F. G. C. BALDWIN, A.M.I.E.E.

It is proposed to give consideration to methods whereby it may be possible to exercise some measure of systematic control in regulating the supply of plant required in connection with systems of telephone distribution, the prime object being to aid the economic provision of cable plant.

The article has particular reference to the more congested portions of large towns and cities, and perhaps it should be mentioned that much of the subject matter is the outcome of consideration given to the procedure best suited to meet the requirements of the most congested portion of the City of London.

The development study has been adopted universally as the basis on which telephone systems are planned, but beyond this, as far as is known, nothing has been done. When once the development study has been made and plant installed, matters have been, more or less, allowed to take their own course. No organised attempt has been made to keep the development study up to date, nor to systematically anticipate any correction in the original layout of plant which may become necessary.

Development studies are made because in telephone work it is necessary for economic and practical reasons to instal a certain amount of plant for future use, which must be spare and is, therefore, non-revenue earning until actually brought into use. Further, such spare plant imposes a charge on revenue by virtue of the annual charges it incurs. It is, therefore, highly desirable that spare plant be kept to a minimum, and also that its installation be deferred until the latest possible moment. Nevertheless, it is equally possible to err on the other side by inadequate provision of plant, and those

CONSTRUCTION THE REGULATION OF PLANT SUPPLY.

with experience will readily appreciate the loss sustained by a process of starvation in supply of plant.

Seeing that the forecasting of development is in the nature of prophecy, it will be obvious that, even with the very best of development studies, prepared on thoroughly sound and scientific lines and subjected to the severest checks possible, certain unforeseen circumstances constantly crop up to upset the original figures. Therefore, if utilisation of spare plant is allowed to proceed without careful inspection of the actual growth, and the actual compared in some way with the estimated growth, due to the vagaries of telephone development it is more than probable that certain cable plant may become exhausted long before the time anticipated, and, on the contrary, other plant may not become remunerative within the planning period, owing to the development falling short of that expected. Hence it is necessary that the engineer should be apprised generally and specifically of the way things are going in regard to the rate at which the plant is being utilised, in order that the requisite steps may be taken to remedy any default caused by unforeseen deviation from the growth which has been provided for.

It is, no doubt, true that, for a densely telephoned area with its steady progress in telephone growth, on which are superposed the fluctuations attendant upon telephone demand, the more mechanical the methods which can be contrived to satisfactorily control the design, and to direct the installation of plant, the less will be the fatigue of mind experienced by those responsible, and, if sound principles govern the mechanism thus employed, greater efficiency will result.

It will, perhaps, be appreciated that, for several reasons, any measures which it may be desirable to take in order to facilitate the satisfactory regulation of plant supply should be in harmony with the development study. Certain features of development estimate work will, therefore, be considered.

The chief function of a development study is to enable a decision to be arrived at in respect of the following :

- (a) Number and position of exchanges.
- (b) Capacity of exchanges and their equipment.
- (c) Extent of exchange areas.
- (d) Route to be taken by line plant.
- (e) Number and capacity of ducts and cables.
- (f) Approximate date at which the several portions of plant will be required.

The development study is required in more precise detail in connection with cable plant than any other portion of a telephone system, and it is desirable that the figures be first supplied in such form and detail as to cover the smaller units of plant. An aggrega-

tion of these figures may then be used for apportioning successively the capacity of the larger units.

Two rather interesting questions arise at this point. On more than one occasion the author has heard it remarked that the necessity for a development study does not exist. The reason given for this statement is that it is impossible to foresee what the development will be, and therefore development figures are never correct and cannot be relied upon.

Inasmuch as it is necessary that spare plant should be laid down, some decision must be arrived at as to the amount of that spare plant, and, even if only a haphazard guess is made, something approaching a development estimate must take place in the mind of the individual hazarding the guess. There is, therefore, no question as to whether a development study is necessary or not, but there certainly is a question as to the degree or extent to which reasoning should be employed in making the study. A further question is, to what extent can the figures arrived at as a result of the development study be utilised, that is to say, what is the limit of application of development figures? It is a fairly simple matter to estimate *en bloc* with reasonable accuracy the development for a large area, but the risk of error increases as the size of the area diminishes. Hence, more difficulty is experienced in deciding the size of the smaller units of plant than is the case with the larger ones.

In the consideration of a telephone area the number, capacity, and approximate positions of the exchanges and the theoretical exchange areas are amongst the first prime engineering considerations after the development study has been made. The actual positions of the exchanges are afterwards arranged to coincide as nearly as possible with the theoretical positions, and practical area boundaries are outlined to follow as far as possible the theoretical boundaries, advantage being taken of such natural boundaries as may exist, such as rivers, railways, canals, etc.

It is most important that such boundaries should be fixed and strictly adhered to. If, for any reason, it becomes necessary that an area should be altered, the matter should be the subject of careful investigation and the alteration determined on an economic basis, all the factors bearing on the matter being taken into account.

Let it now be assumed that development figures have been prepared and applied, that each exchange area has been carefully examined, and as a result of these investigations new distributing areas and service areas have been provided, also, where necessary, the existing areas adjusted, and, finally, that plant has been installed on an economic basis to provide for the period or periods previously decided upon.

CONSTRUCTION THE REGULATION OF PLANT SUPPLY.

We may now proceed to the consideration of the means whereby the adequacy of the plant may be kept under constant observation.

It should also be assumed that, in accordance with accepted practice, the development figures have been assembled according to certain areas, viz.:

- (a) Service areas;
- (b) Distributing areas; and

DEVELOPMENT RECORDS. I.

SERVICE AREA DEVELOPMENT RECORD. EXCHANGE MAIN CABLE CODE												
SERVICE AREA CODE NO. /					NO. OF PAIRS PROVIDED							
SERVICE AREA LOCATION					NO. OF PAIRS AVAILABLE							
MONTHLY RECORD OF WORKING CIRCUITS.												
MONTH	FOR YEAR			FOR YEAR			FOR YEAR			FOR YEAR		
	NO. OF CIRCUITS	DIVERSIONS + -		NO. OF CIRCUITS	DIVERSIONS + -		NO. OF CIRCUITS	DIVERSIONS + -		NO. OF CIRCUITS	DIVERSIONS + -	
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												
11												
12												
NET INCREASE			NET INCREASE			NET INCREASE			NET INCREASE			
% INCREASE			% INCREASE			% INCREASE			% INCREASE			
% RATIO $\frac{\text{WORKERS}}{\text{TOTAL}}$			% RATIO $\frac{\text{WORKERS}}{\text{TOTAL}}$			% RATIO $\frac{\text{WORKERS}}{\text{TOTAL}}$			% RATIO $\frac{\text{WORKERS}}{\text{TOTAL}}$			

2923

I.

(c) Main cable areas (if found practicable).

These areas are respectively served from—

- (a) Service points;
- (b) Distributing points; and by
- (c) Main cables.

The circuit capacity of the cables feeding service points, distributing points, and of the main cables themselves, has been apportioned as a result of the development study.

Hence, any record instituted for the purpose now in view should be directly applicable to these three items.

It does not appear practicable or economical to adopt special records of this character in connection with small distributing cables.

THE REGULATION OF PLANT SUPPLY. CONSTRUCTION

A suitable card for recording the growth is illustrated in 1. Provision is made for monthly entries of the total number of working circuits. These may be made on the first day of each month up to the evening of the previous day.

By means of this card it is possible to contrast the number of working circuits with the total circuit capacity of the cable, and also in cases where the full number of circuits are not joined through to the exchange with the available circuits which are so connected.

DEVELOPMENT RECORDS. 2.

DISTRIBUTING AREA DEVELOPMENT RECORD. EXCHANGE MAIN CABLE CODE												
DISTRIBUTING AREA CODE NO.					NO. OF PAIRS IN BRANCH							
DISTRIBUTING AREA LOCATION					NO. OF PAIRS AVAILABLE							
MONTHLY RECORD OF WORKING CIRCUITS.												
MONTH	FOR YEAR			FOR YEAR			FOR YEAR			FOR YEAR		
	NO. OF CIRCUITS	DIVERSIONS + -		NO. OF CIRCUITS	DIVERSIONS + -		NO. OF CIRCUITS	DIVERSIONS + -		NO. OF CIRCUITS	DIVERSIONS + -	
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												
11												
12												
	NET INCREASE			NET INCREASE			NET INCREASE			NET INCREASE		
	% INCREASE			% INCREASE			% INCREASE			% INCREASE		
	% RATIO ~~WORKERS~~ TOTAL			% RATIO ~~WORKERS~~ TOTAL			% RATIO ~~WORKERS~~ TOTAL			% RATIO ~~WORKERS~~ TOTAL		

2924

2.

It will be noticed that provision is made for indicating the number of "diversions" from or to the particular cable to which the card refers. This is necessary in order that transfers of existing working circuits from one cable to another, which become necessary from time to time, and which must not be regarded as natural growth, may be duly allowed for.

The card shown is one designed for use in connection with service points.

2 shows a similar card for recording the growth at distributing points, and

3 illustrates a further card for similar use in connection with main cables.

CONSTRUCTION THE REGULATION OF PLANT SUPPLY.

It will be observed that no distinction is made between the different classes of line, *i.e.* direct exchange lines, private lines, external extensions, etc., the sum total only of all classes of line being entered. If considered necessary columns might be provided for separate entries for each class of line, but this seems to be an unnecessary refinement. The information required for the monthly entries on these cards could be obtained from cable records either the same or similar to those at present in use.

DEVELOPMENT RECORDS. 3.

MAIN CABLE DEVELOPMENT RECORD						EXCHANGE						
MAIN CABLE CODE						NO. OF PAIRS IN CABLE						
						NO. OF PAIRS AVAILABLE						
MONTHLY RECORD OF WORKING CIRCUITS												
MONTH	FOR YEAR			FOR YEAR			FOR YEAR			FOR YEAR		
	NO. OF CIRCUITS	DIVERSIONS		NO. OF CIRCUITS	DIVERSIONS		NO. OF CIRCUITS	DIVERSIONS		NO. OF CIRCUITS	DIVERSIONS	
		+	-		+	-		+	-		+	-
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												
11												
12												
	NET INCREASE			NET INCREASE			NET INCREASE			NET INCREASE		
	% INCREASE			% INCREASE			% INCREASE			% INCREASE		
	% RATIO ^{WORKERS} TOTAL			% RATIO ^{WORKERS} TOTAL			% RATIO ^{WORKERS} TOTAL			% RATIO ^{WORKERS} TOTAL		

2925

3.

At the end of each year a summary of all the main cable circuits similar to the example illustrated in 4, may be prepared. In this case separate columns are provided for each class of line, and the total of the column, headed "D.E.L.," will give the total direct exchange lines working on the exchange at December 31st. This figure should, of course, agree with the exchange records.

Lines working on other exchanges, but which may pass through the one for which the record is being compiled, might be entered separately in one of the spare columns provided.

In this record it is considered that an analysis of the lines would prove useful, as it would enable the annual increases of each class of line to be readily determined.

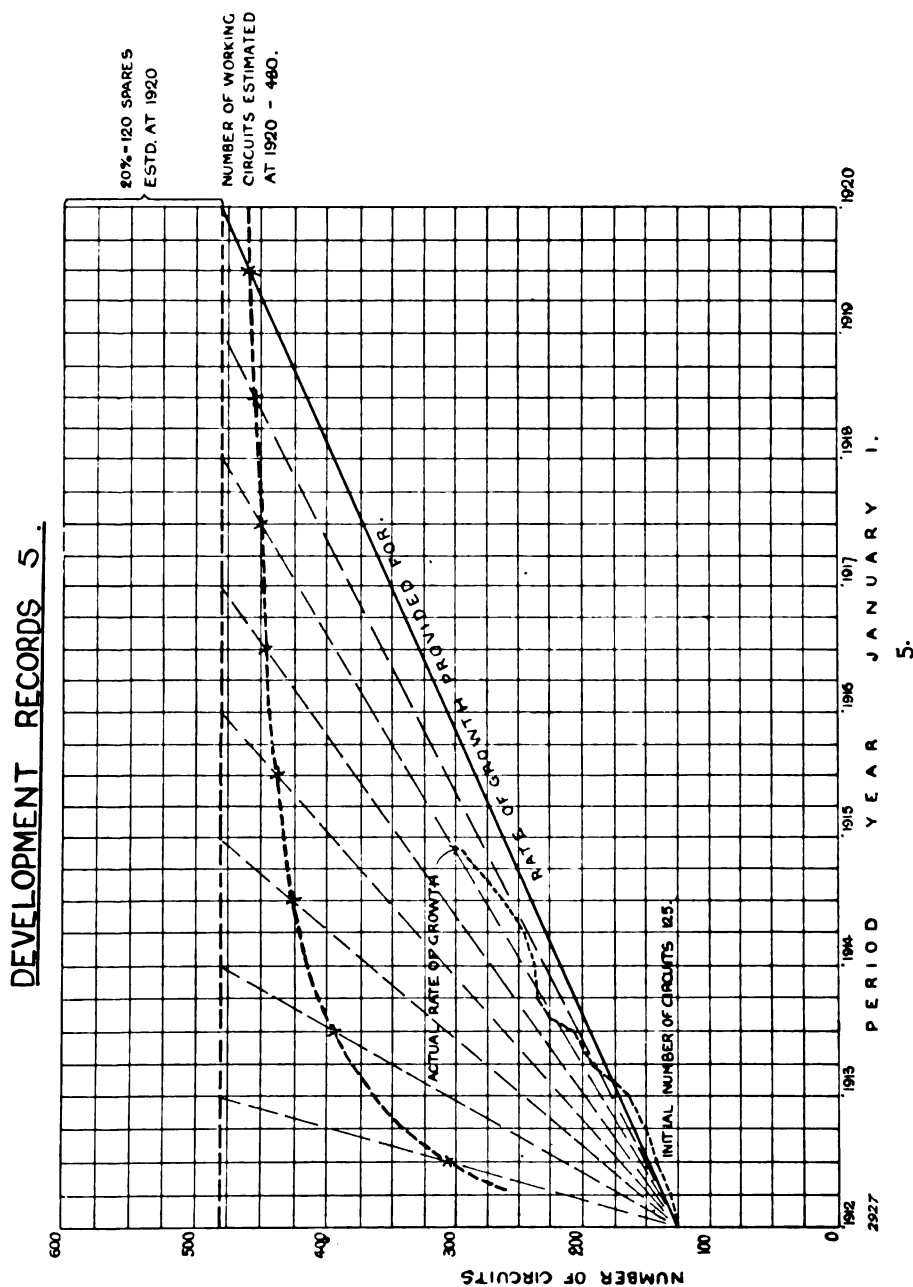
No doubt it will be readily appreciated that the tabulated figures

DEVELOPMENT RECORDS. 4.

[illegible]

CONSTRUCTION THE REGULATION OF PLANT SUPPLY

shown on the face of the cards which have been illustrated cannot be conveniently used for summing up the situation in regard to the



state of exhaustion of a cable, and, therefore, a graphical representation of the growth, which will convey at a glance what is thus required to be known, is to be recommended.

With this end in view, on the back of each card record for main cables, distributing points and service points, a curve may be plotted from the figures on the face of the card.

5 shows such a curve. "Months" and "years" are plotted as abscissæ and "number of circuits" as ordinates, the former covering the whole period from the time at which the cable is originally brought into use to the estimated date at which its capacity will be exhausted. The "number of circuits" covers the total number of pairs in the cable. A straight line is drawn representing the expected rate of growth, and the actual rate of growth is superimposed upon it, plotted monthly from the figures entered on the face of the card.

In this way the relationship between the anticipated and the actual rate of growth is clearly indicated, and a very good idea may readily be gathered as to how things are going by a more or less casual scrutiny of the curves. To go a step further, if we can, by any means, find a method for indicating more precisely the deviation of the actual from the anticipated growth and the instant at which schemes for new cable plant should be initiated, a decided advantage will be gained.

To accomplish this as far as appears possible a further curve has been devised, and is also exemplified in 5. The full capacity of the cable has been taken to be 600 pairs, and it is assumed it is intended that its capacity shall be exhausted within 20 per cent. at the end of the period for which the cable has been designed to serve; in this case at the end of eight years. In other words, at the end of the period there will be 480 working circuits. At this stage, in order to obtain the required result, it is necessary to fix upon the period of time which elapses from the time of initiation of a cable scheme to the time at which the cable projected is laid and ready for use. This period is, of course, a variable one, depending upon the time taken to prepare, consider, and obtain sanction for the scheme, and to manufacture, deliver, and complete the installation of the cable.

In the example six months has been taken as a suitable period.

Referring to 5 it will be observed that a series of assumptions has been made that a cable fills up, first in one year, second in two years, third in three years, and so on up to eight years, and that straight lines have been drawn respectively representing these assumed growths. Now, if six months be allowed for the completion of a relief scheme in each of these cases, we obtain a series of points situated successively on the straight lines representing the assumed growths, and a curve may then be drawn through these points as shown.

For want of a better name, this curve has been termed a "danger curve," and if at any time the actual rate of growth line which is

CONSTRUCTION THE REGULATION OF PLANT SUPPLY.

plotted month by month, as previously indicated, crosses, or very nearly approaches this danger curve, then we have a fairly good indication that immediate consideration should be given to the provision of relief. The relief may be in the form of an entirely new cable, or may consist merely of a redistribution of the existing spare circuits, according to circumstances.

A further value of the development record cards just described lies in the use to which they may be put in the preparation of subsequent development estimates. In predicting development most valuable assistance may be rendered by a study of the past growth and its local and general fluctuations, and the circumstances which have caused them.

The past growth is, perhaps, the most valuable guide it is possible to possess, and a record of it should, therefore, be available in such a form as to be suitable to the requirements of the officer responsible for the development study. By means of these records a history of the development of an exchange area (*i. e.* from the date the record commences) might be traced, not only in regard to the area as a whole, but also in regard to the very small portions of it represented by the service and distributing areas previously mentioned.

So far as is known the only running records of development which have hitherto been recognised as necessary are records of lines and stations per exchange, and, as in many cases diversions from one exchange to another have not been taken into account, these cannot be regarded as a true record of the growth.

The rate of development varies considerably according to the type of locality, *i. e.* according as to whether it is manufacturing, commercial, residential, etc. Moreover, different localities are subject to fluctuations which are not common to the whole area, all of which would be recorded on the card records described. Remarks as to the cause of such fluctuations and deviations from the estimated growth might be entered on the cards, and their use to the development officer thereby enhanced.

Quite apart from the records described, it is desirable that the development study should be kept under constant review and the original figures revised from time to time. It is suggested that this should be done annually, and also that simultaneously the original figures should be advanced by the same length of time. That is to say, if the development figures have initially been given to cover periods of eight years and fifteen years (the planning periods for underground plant adopted by the Department), then at the expiration of the first year the development figures would be adjusted so as to still cover eight and fifteen years.

These new figures would be, more or less, a projection of the original figures modified according to the past year's actual progress,

THE REGULATION OF PLANT SUPPLY. CONSTRUCTION

and also by any circumstances which may have arisen during the period which has elapsed, likely to cause a variation.

It is desirable that this should be done, because at any moment it may be necessary for the consideration of some new project caused by an alteration in policy, by an unexpected abnormal growth or even by ordinary growth, to have immediate recourse to the development study, and, presuming that plant is still to be laid to provide for the same length of time, then, unless the development study is up to date as suggested and available for immediate reference, much valuable time may be lost or uneconomical provision of plant take place.

A form has been drawn up and is illustrated in 6, which might be conveniently adopted for this purpose. It will be observed that provision is made in the vertical columns of the form for the extension of the development estimates year by year in respect of each

[illegible]

6.

service area, and the form would be used in conjunction with the plans on which these areas are outlined and coded to correspond.

The suggested records which have been described are those required primarily for the purpose of following the rate of exhaustion of spare cable plant. They have numerous other uses, however, and can readily be arranged in such a manner as to form part of the cable records proper. If combined with a system of test room and cable plant records, it is thought that the engineer would be provided with an excellent means of control over his plant not hitherto possessed.

In conclusion, if precautions of some sort or other in the direction indicated be not taken, the result must undoubtedly be that the control which it is so necessary should be exercised over the provision of spare plant is lacking, and the continuity of the progress of new line connections is either broken or becomes irregular, and it may be that uneconomical methods must be resorted to in order to cope with demands.

It may be argued that the cost of carrying out such a process of

CONSTRUCTION TRANSFER OF SMALL EXCHANGES.

investigation and of providing and maintaining the somewhat elaborate system of records will be high. It is not intended to deny such an assertion, but in justification of the prosecution of some similar system to that which has been outlined, it is pointed out that the cost will be but a very small fraction indeed of the annual charges on the capital outlay on the plant controlled.

No figures have been prepared to indicate what the cost would be, but it seems apparent that the saving effected is likely to be great and such as to show a very big margin on the right side, not to mention the gain in efficiency which it is thought would be realised.

NOTES ON THE TRANSFER OF SMALL EXCHANGES.

By W. S. TINSLEY.

*Summary of a Paper read before the Institution of Post Office
Electrical Engineers at Leeds, October, 1913.*

THIS paper may be conveniently divided into:

- (1) Preliminary.
- (2) Estimating.
- (3) Preparation.
- (4) Transfer.

PRELIMINARY.—The first points that arise are what kind of an exchange is involved, and what class of building is affected.

It is very necessary to have a clear understanding as to whether the Secretary, Surveyor, independent postmaster, head postmaster, district manager, or Board of Works representative should be individually or collectively consulted on any points concerned. Each class of office will determine the proper authority for certain matters, and in order to avoid delay and facilitate smooth working it is certainly useful knowledge to have one's proper bearings in this respect. I suggest close attention to Engineering Regulations, Circular E12, Circular to Surveyors, No. 35, and also to Circulars to Surveyors, No. 48, 1911, and No. 34, 1912.

Obviously, no set schedule of rules could be framed to meet every class of transfer, and as the possibilities and conditions of the numerous cases are so varied, each transfer must be dealt with according to its particular merits. I have, therefore, selected as a typical case, for the purposes of this paper, the transference of an exchange of 200 subscribers from an ex-company's exchange to a post office in a town of five or six thousand inhabitants with mixed business

and residential characteristics, and my remarks will be practically confined to such a case. Usually, in such a town, the post office is a Class 2 building, *i.e.* the accommodation is provided by the landlord, generally upon a long lease of rental to the Department for, say, twenty-five years. Assuming that the accommodation at the existing post office is inadequate, the Surveyor will decide whether the existing building can be enlarged, or fresh premises must be provided; if the latter be decided upon, the important question of the ideal centre, from a telephonic point of view, should not be overlooked. The landlord usually instructs his architect to prepare plans and specifications covering the department's requirements, based upon preliminary inquiries made of the Postal, Traffic, and Engineering Departments. These plans are then submitted to the Secretary (Buildings Branch) for scrutiny, and are subjected to criticisms, suggestions, and amendment so far as the general layout, sanitation, ventilation, builders' quantities, specifications of material, etc., are concerned. The plans are then passed forward for the scrutiny of the Engineering Department. The careful consideration of our requirements at this stage is most important, and this point cannot be too strongly emphasised, so as to obviate the necessity for amendments later on. When once the plans have been passed and building instructions issued, it is very irritating to an architect to have to amend his final specifications and quantities, to say nothing of the possible second application to the Treasury for additional authority.

The chief points for consideration at this stage are :

- (1) Accommodation, *i.e.* (a) switch room, (b) test room, (c) battery room, (d) inspectors' room, (e) linemen's room, (f) light stores accommodation, (g) heavy stores and carts, (h) ladders, (i) gas engine and dynamo.
- (2) Provision for overhouse standard.
- (3) Cable chutes, chasings, and casings.
- (4) Illumination.
- (5) Heating.

ACCOMMODATION.—Approximate particulars of accommodation for engineering purposes, so far as rooms are concerned, are given in Circular to Suveyors, No. 35, but these only represent a rough guide for general purposes. Ordinarily 200 subscribers would only warrant a non-multiple C.B.S. installation, but prospective conditions and traffic estimates may demand a multiple exchange equipment, necessitating entirely different accommodation.

For instance, in the case of a C.B.S. exchange, an ordinary switch room or separate test room accommodating a main frame where space can reasonably be afforded, and a separate moderately-sized battery room would be the chief item, but if a C.B., No. 1,

CONSTRUCTION TRANSFER OF SMALL EXCHANGES.

switchboard be decided upon, then in addition to the switch room accommodation a sufficiently large test room will be needed to hold the power board, fuse board, charging plant, ringing machines, M.D.F. and I.D.F., and a separate room for secondary cells. These purely engineering arrangements are most conveniently placed in the basement or ground floor, where the question of weight is not an acute one, but if a first, second, or higher floor is to be occupied, then the important points of strength of walls, joists, beams, rafters, and distributed loads arise. It will be necessary to obtain the approximate weights of the heavier items of apparatus from the Engineer-in-chief, and to ascertain from the architects the stability of the floors, walls, etc. This question of weight, of course, arises in the ordinary case of C.B.S. switchboard equipment, but for such cases it may generally be taken for granted that the ordinary joisted floor is sufficient to carry the distributed loads involved.

Generally for an exchange of 200 subscribers a room suitable for two men, with accommodation for a normal stock, will suffice, in addition to a ladder rack 20 ft. to 25 ft. long.

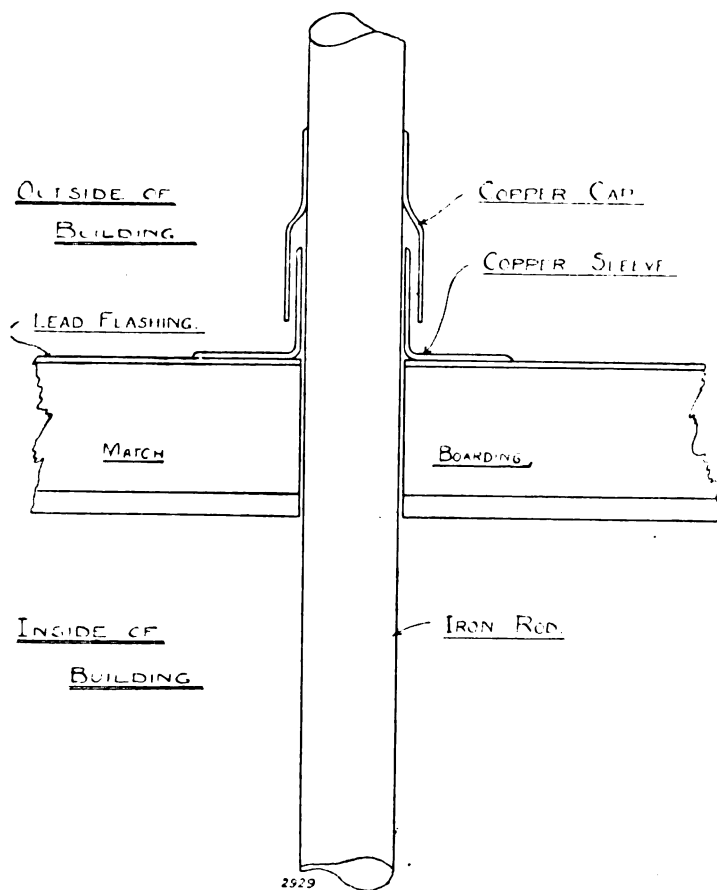
GAS ENGINE.—In the case of a C.B. equipment—if there is no town supply of electricity—it will probably be necessary to instal a gas engine, dynamo, and controlling switchboard, and on account of the noise of the gas explosions this machinery should be housed in a detached building, if at all possible, as far away from the main building, especially the switch room, as practicable. Usually an out-house, approximately 15 ft. $\times$ 12 ft., will suffice, and the provision of such must be included in the plans and early steps taken to lay one or two 3-in. pipes during building operations to accommodate the charging cables between the dynamo and the test room. The floor of the dynamo shed should be concreted and the room capable of ventilation and free from damp. The provision of the bed for the gas engine and dynamo will be included in the tender for the supply of the plant.

If a C.B. equipment is concerned, the exchange is likely to demand the continual attention of at least one engineering officer, and it may be that the exchange is, or will be, the headquarters of two or more linemen and an inspector. Proper accommodation for them should not be overlooked, and for disciplinary purposes I should recommend a separate room for the inspector, whenever the conditions are reasonable.

OVERHEAD STANDARD.—The question as to what extent underground, if any, will be used, or whether open work only shall be followed, should be known at this stage, and the point determined as to whether an overhead standard or ground pole will be required. In the simplest case, and if any proper staying facilities exist, the requirements may be met by a good, stiff, creosoted or pitch-pine

TRANSFER OF SMALL EXCHANGES. CONSTRUCTION

pole, or a good H. pole. If, however, the building is anything above 30 ft. high and considerable open distribution at this point is involved, there is need for the provision of an overhead standard. The latter may be of the single pole, triangle, or square type. It is useful to remember that a single pole standard can be arranged to form the nucleus of a triangular standard, and for this reason it is always more economical to fix a single pole standard at the outset



I.

and increase to a triangular fixture afterwards, if necessary, but it will also be economical to fix both iron girders in position whilst the building is in course of erection. The girders and wall plates should be to hand when the architect is ready, but until such plates are in position the holding-down rods (the exact length of which is an important point) should not be ordered. A lead flat, with access thereto, and stone templates for supporting the girders should be

CONSTRUCTION TRANSFER OF SMALL EXCHANGES.

included in the plans, and arrangements with the architect made for anchoring the girders and staying the pole. If the anchor rods have to pass from the outside to, say, an inside wall, the contraction and expansion of the rods present a difficulty in excluding rain, but this difficulty can generally be overcome by a simple arrangement as outlined in I.

CABLE CHUTES AND CHASINGS.—The plan should be marked with the necessary cable chutes and chasings, but until the particulars of the equipment and its lay-out have been furnished by the Engineer-in-chief the dimensions of the various cable chasings and runs must be left in abeyance. It is nevertheless essential that the particulars be supplied early, in order that the contractor may provide what is necessary before his construction gets too far advanced. Where an external chamber is to be provided, it will be nearly always possible to determine on the plans the runs for the main chute or chutes to the test room.

If underground cables are involved, and there is no cellar whereby they can enter the building, it will be advantageous to have provided a cable-turning chamber on the ground floor, in order to turn the main cables close to the wall as they pass to the floors above.

ILLUMINATION.—This is another important point, and one likely to affect the engineer. If gas is to be installed, this will be seen to by the Surveyor, but all the points of illumination in the engineering quarters must be set out—not forgetting the possible supply for the gas engine with its separate meter, also a supply to the auto gas stoves—and possibly to a gas cooker for the linemen's room. From a fire risk point of view, fixed wall brackets are preferable to movable jointed ones, but 2-, 3-, or 4-light swinging ceiling chandeliers which move freely in all directions, but well clear above the M.D.F. and switch sections, are permissible.

If electric light is to be the system of illumination, the Surveyor will mark all the points other than the engineering quarters and pass the plans for the engineer to fix the points for his own rooms, and then furnish the necessary particulars for estimating purposes, which will be prepared upon standard lines. The Engineering Department sees to the invitations for tenders for the wiring, examines samples submitted, and supervises the work of the contractors when they undertake the work. If the housekeeper's quarters are to be wired, it will be necessary to have them wired on a separate circuit, and for accounting purposes an independent meter should be supplied.

HEATING.—Still another important point is that of heating. The architect will draw up his specifications for heating, and these will be submitted by the Surveyor for scrutiny to the Engineering Department. The chief points to watch are:

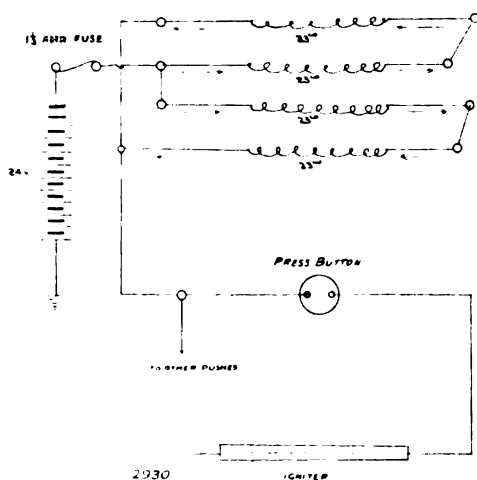
TRANSFER OF SMALL EXCHANGES. CONSTRUCTION

Boiler.—Heating capacity, provision of thermometer, safety valve, manholes and facilities for cleaning, draining-off, and stoking.

Pipes.—Size, sufficiency of surface, controlling valves, vent pipes, and draining-off facilities.

Radiators.—Sufficiency of heating surface, baffle plates, ventilators, vents, controlling valves.

A proper set of firing tools should be included in the supply, the lagging of the boiler and outside pipes should be included, and the draining system connected up to a convenient sink. The boiler, pipes, and radiators should be painted. The storage for coke should be handy and stoking operations easy.



2.

The installation will be undertaken by the contractor, but supervised and finally tested and passed by the engineer.

The whole of the foregoing remarks apply to the preliminary, or consideration of plan stage, and it is very necessary that the various points receive careful consideration.

FURNITURE.—Having satisfactorily settled these matters, the engineer might conveniently consider the question of furniture at this stage. This is not a difficult matter, but it is nevertheless essential, whether an entirely new supply or only additional items be needed. The requisition should be made out in accordance with Appendix 3, Regulation Book, and should go to the Superintending Engineer. The regulation affords a generous supply of items to linemen and inspectors, but I would advise the avoidance of asking for unnecessary items merely because they are included in the standard list. Just as the Board of Works supplies furniture, etc., for Class 1 property, so

CONSTRUCTION TRANSFER OF SMALL EXCHANGES.

does the surveyor, generally speaking, see to the supply for Class 2 offices.

The provision of fire appliances is particularly important. It should be borne in mind that the officer actually responsible for the fabric of the building will provide the necessary fire fighting appliance.

Matches should not be permitted, but electric hand torches or pyrophoric lighters should be supplied, or the arrangement shown in 2 provided.

ESTIMATING.—This will need careful consideration, and a development study, if possible, should be made of the town. I have no hesitation in advocating the use of underground distribution as far as possible. The standard instructions state that, as a general rule, fifty open wires (twenty-five circuits) will be the maximum on an open route, and if fifty wires set out from a D.P. the open route must necessarily gradually diminish to insignificance. Of course, at a breaking-out point, there is no objection to many more wires radiating therefrom. If a suitable spot is forthcoming for a D.P. I see no reason against loading such a D.P. up to 100 wires, or even more, especially if the radiation is fairly general and assists in maintaining the equilibrium of the pole. In towns similar to that which I am dealing with, conditions obtain in connection with the existing plant, which are altogether strange to pre-transfer men. Hitherto, we have generally been successful in taking our open trunk and telegraph routes direct to the post office by way of public streets, but the National Telephone Company had to resort to nooks and corners on private property for their poles and fixtures. Very heavy wayleave rentals had frequently to be paid for such privileges, and in many cases very large sums for overhanging private property had to be met annually. It should, therefore, be an important point to consult the wayleave records in a general way for all such undesirable easements, which may, in a great measure, be the deciding factor for providing underground plant. It will have been gathered that I do not advocate an entirely underground system for a transfer of 200 subscribers, but what I do suggest is that future development figures, wayleave difficulties, and heavy payments may justify a certain amount of underground cable to suitable breaking-out points. In estimating for such a scheme care should be taken to avoid private and doubtful private property for D.P.'s. It is generally an expensive matter to divert a D.P. from private property; therefore, whenever possible, the D.P.'s should be placed on public property.

In preparing the underground estimate the utility of laying a spare pipe in open trench across, say, an important main thoroughfare or other difficult position should not be overlooked. It is very economical to take advantage of an open trench, and may save a good deal of subsequent expense. The earth plate, bonding, ring

bolts, steps, and other items for manholes must not be forgotten, and provision should be made for the cantilevers or four or seven lug cable supports for the pit channel surface boxes. I merely mention these items because my experience is that they are the stores chiefly overlooked; the other important matters, like the "pounds" in the proverb, take care of themselves.

CABLE SUPPORTS INTERNAL.—Cantilevers inside the building, or supports of angle-iron with sheet-iron shelves for supporting the main cables between the chute and the M.D.F., are often necessary; the latter will cost about £2, and will be covered by small purchases. For a C.B.S. exchange of the size mentioned, two sections of M.D.F., 480 wires each, fitted with heat coils, fuses, and protectors for the actual wires, an auto gas heating stove, stand, bracket, and hood will be required.

HOUSE TELEPHONES AND PNEUMATIC PUMP.—It is possible that on account of the transfer of the telephones the importance of the Post Office now demands the installation of a house telephone system and a pneumatic service. These are arrangements that should be requested by the surveyor, but if there be a likelihood of the points being overlooked it is to the engineer's advantage to draw attention to the points, so that the whole of the work may be put in hand concurrently or in proper sequence. Separate estimates will be needed.

The house telephone system calls for no special comment, beyond a note upon the difference between secret and non-secret systems; generally the latter will suffice. In estimating for the pneumatic service, the disposition and importance of the counter, delivery, instrument, and switch rooms should be studied, with a view to deciding as to the installation of an ordinary pneumatic hand-pump and tubes, as against a "roots blower." If there be no town supply of electricity a "roots blower" is out of the question, on account of cost, but in framing the estimate for the ordinary pneumatic tubes and pumps care should be taken with regard to the flanges, and whether the pumps should be left or right, horizontal or vertical. It may be mentioned that the latter terms apply to the stroke of the piston; the horizontal stroke is chiefly used.

PREPARATION FOR TRANSFER.—Previous to carrying out the work the engineer will have submitted particulars of wayleaves required from the local authority, and received the necessary consents. Usually a line of pipes includes the necessary boxes, and a pole should include the necessary staying facilities, but some local authorities insist upon stays being regarded as separate easements, and demand that they, as well as the position of the jointing chambers, should be clearly set out. The extent of any underground required will be the determining factor as to whether the Engineer-in-chief will let the work out to contract or authorise it to be done by the engineer's

CONSTRUCTION TRANSFER OF SMALL EXCHANGES.

local staff. If a contractor is to undertake the work, the contract will be based upon particulars given in the paving schedules furnished by the engineer, who will also have ascertained whether the local surveyor desires to carry out the reinstatement, or whether he agrees to its being done by the contractors. Some corporations have insisted upon doing both trenching and reinstating. Generally speaking, it is satisfactory for the contractors to do the work, as the Department is thereby relieved of the difficulty of giving satisfaction to the local surveyor regarding reinstatements. Assuming that the contractor has tendered for the whole work, the engineer will see that all wayleave matters are clear ahead, and that the contractor starts the work in good time and completes the daily or weekly portion as per contract. The clerk of works watching the operations will keep his diary and prepare the plans as the work proceeds giving sectional and plan drawings of the ducts. He should carefully watch and check the "extras," and see that they are daily recorded by the contractor in the diary at hand for inspection at any time. It will be the duty of the engineer to see to the fulfilment of the "Fair Wages Clause," and to actually check the pay-roll and wages of the contractor's men. There is a special form, Engineer-in-Chief 173, upon which the engineer notifies the contractor of the proposed date of check. The clerk of works should see that the contractor strictly adheres to the departmental methods of laying underground. He should not permit of any filling-in before he has satisfactorily passed the section of work.

In the meantime, the cable lengths will have been sent in, and here let me emphasise the importance of correctly measuring each length required in order to avoid piecing cables and cutting-in extra boxes. The lengths should be requisitioned for delivery as soon as the duct work is completed. Arrangements for one or more jointers will also have been made, so that they can commence their work immediately it is possible to do so. Nothing greater than a 25-pair cable should terminate at a D.P. The new solid plugs are supplied in suitable sizes, but, if for any reason a large number of wires have to terminate at a particular D.P., the branching cable should terminate in two or more solid plugs properly "staggered." It will be found advantageous, in order to exclude wet and dirt, to case-in the leads up the pole and to bring the ends out in a downward direction slightly above the arm concerned. The usual tests should be strictly insisted upon, and the numbering of the cables commenced with the highest number at the remotest point, gradually multiplying in the various branches to the external chamber at the post office, where a numbered joint will be made on each cable. As the cables pass through surface-boxes they should be neatly laid side by side upon cantilevers or cable supports which have been

faced with lead (to prevent electrolytic action) and securely fastened by tape. Extended experience has proved that once the cables are laid properly and a good method adopted at the boxes, little or no trouble occurs, whereas a slovenly manner very soon causes trouble. Each cable and its branch should be coded at each box and the appropriation recorded on T.E. 336 and cards T.E. 280, 403, and 405. These, together with 25" map markings, should be sufficient records for all practical purposes in the case under consideration.

OPEN WORK.—Whilst the underground work is in hand, the preliminaries in connection with the re-arrangement of the open wires should proceed. It will be essential to make pole plans of all D.P.'s and probably every pole within the area of the underground scheme, in order that party lines and ordinary subscribers' circuits can be intercepted at the most convenient point. In small towns it frequently happens that the X and Y subscribers of a party line are at the opposite ends of the town, and in such cases it will probably be found more economical to "tee" the branches at the M.D.F., utilising spare underground wires instead of cross-country open wires. Close attention should be given to correctness of the particulars for the pole plans, which should be obtained by actual tapping out, or speaking tests "teed." Connections may now be taken from the various poles to the new D.P.'s, either by means of open wires or by interruption cable; and when the underground length is joined through, each circuit should be proved by speaking over it from the new M.D.F., recording the fact, and leaving the ends disconnected there.

INTERNAL WORK.—If the installation is to be of the C.B.S. type the engineer is responsible for: The building up of the internal work, *i. e.* the switch, test, and battery rooms. Engraving labels, lamp-cap or service markings, and various similar small items should be requisitioned in time, and should be fixed in position by the opening date in order to avoid the use of unsightly pieces of paper as makeshifts. All battery leads should be properly marked. The fixing of the switch sections should leave adequate working space at the rear. During the indoor installation the accumulation of empties, packing, or rubbish should be cleared from each room at the end of each day.

If the installation is to be undertaken by contractors, the Engineer-in-chief issues all instructions and furnishes all particulars, supplying a set of diagrams for the guidance of the engineer who supervises the carrying out of the installation. The contractor must hand over the whole plant in proper working order; he is, therefore, responsible for making good all defects found during the inspection, by testing out or by other means. It should be arranged for one or two linemen to take the long watch during the continuance of the initial charge of the secondary cells and to record the necessary particulars.

CONSTRUCTION CARDIFF POST OFFICE ELECTRICAL SUPPLY.

Usually the date of transfer is decided upon three or four weeks in advance, and the engineer, having obtained formal authority from the Engineer-in-chief to proceed with the opening of the exchange (*vide* from T.E. 271), should adhere to the date quoted. In a properly conceived method of operations the final threads should draw nicely together at the desired time, always provided, of course, no unforeseen difficulties arise.

TRANSFER.—We now expect the M.D.F. to have been wired, the switch sections lined up, wired, and connected to the M.D.F., jumpers in position, and a final speaking test made from the new switch to the subscribers, recorded, then plugged up; the number joints made and recorded at the external chamber, solid joints from the S. and C.C. ends properly sealed, all cables pressure tested, batteries in working order, relays and special junction and other circuits proved. The superintending engineer and district manager will have been finally advised that all is in readiness for the change as arranged. This can very well be fixed to take place at eight o'clock in the morning, when everything is comparatively quiet, and unless there are special reasons to the contrary I see no necessity for, nor has experience shown me, any advantage in transferring such an exchange at a week-end.

On the Day of Transfer.—All that is now required is to have a man at the old exchange, one at the new switch section, probably one at the M.D.F., and, if any doubt as to the outside work, one at the D.P. At a given signal the whole of the plugs on the working circuits on the new switch section should be pulled out and the circuits plugged up as quickly as possible at the old exchange. The operator should then be requested to speak to each subscriber and satisfy herself that all is in order. Afterwards the work of disconnecting the old work may proceed. The "teed" lines should next be joined through permanently, the old lines cut away, all unnecessary lines recovered, all poles straightened up, leads permanently sealed in insulators, arm-slots filled in, and poles generally tidied up, the apparatus and batteries dismantled at and despatched from the old exchange in good time, and preparatory to the district manager making his arrangements with the landlord for the restoration of the old premises.

CARDIFF POST OFFICE ELECTRICAL SUPPLY.

By W. SCOTT.

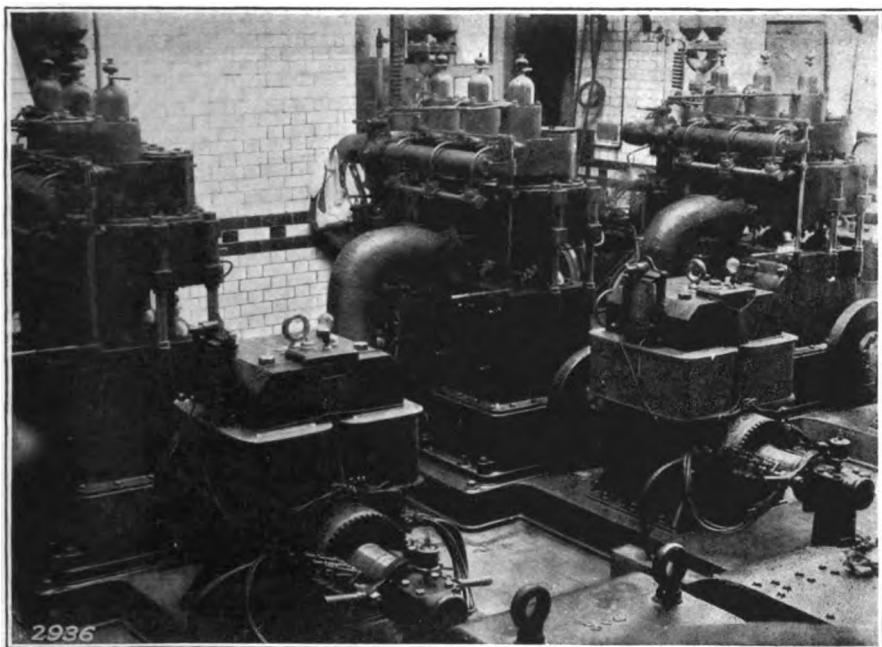
ANOTHER of the Department's generating stations closed a useful career when the one at Cardiff Post Office finally shut down last year.

CARDIFF POST OFFICE ELECTRICAL SUPPLY. **CONSTRUCTION**

The transfer to the Corporation supply involved the scrapping of the whole of the generating and pneumatic pumping plants, and the installation in the basement of the main building of a new power board and two new electrically driven pneumatic sets.

The exhaust steam from the generating station had always been used for the calorifiers of the heating plant, situated in the main building, and it was, therefore, necessary to replace the calorifiers by two 4-B-11 "Ideal" boilers.

The generating station was a building specially provided for the

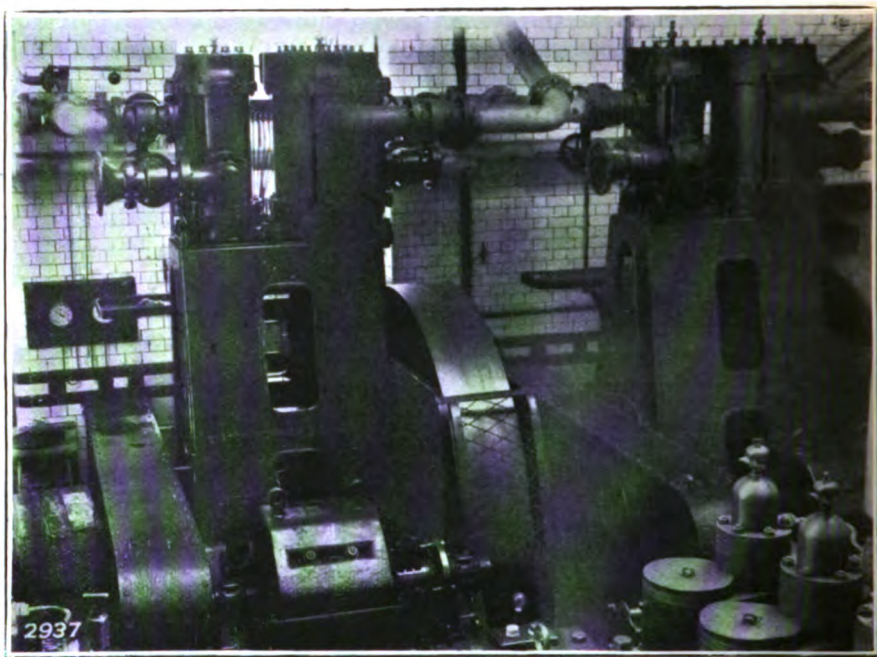


I.—THE OLD GENERATING SETS.

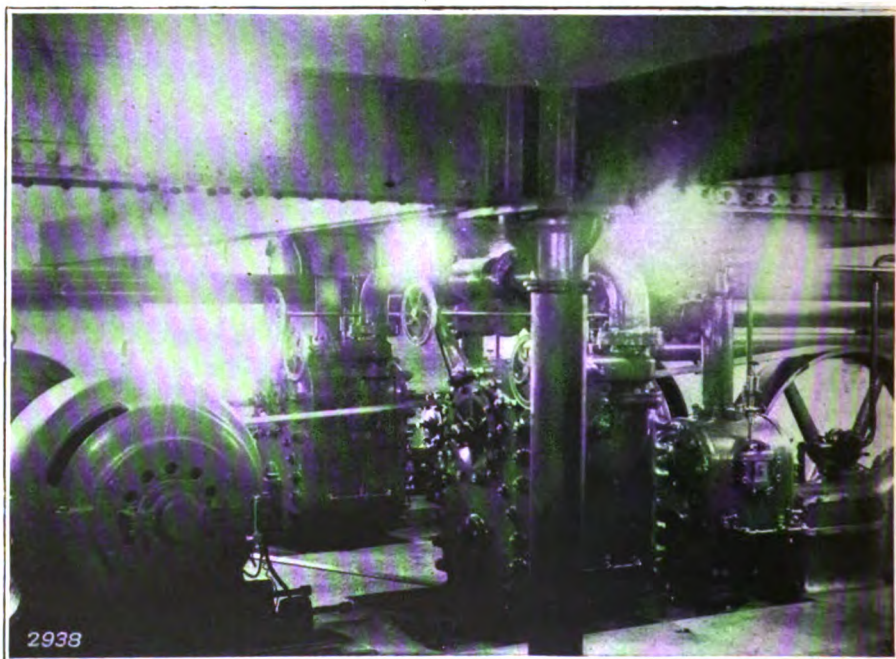
purpose in the Post Office yard. It was lined with glazed brick, and comprised an engine room and a boiler house. Two smoke-stacks were provided.

When installed in 1897 the plant was quite up to date, and consisted of three Babcock and Wilcox water-tube boilers, with an exhaust-steam, feed-water heater, three Peache-Johnston and Phillips steam driven, direct coupled generating sets having approximately 150 K.W. capacity at 110 volts, and two vertical, electrically driven, pneumatic pumps (see **1** and **2**).

In 1905 considerable fuel economy was effected by the provision of steam driven underfeed stokers. These were fitted with forced draught.



2. -THE OLD PNEUMATIC PUMPS.



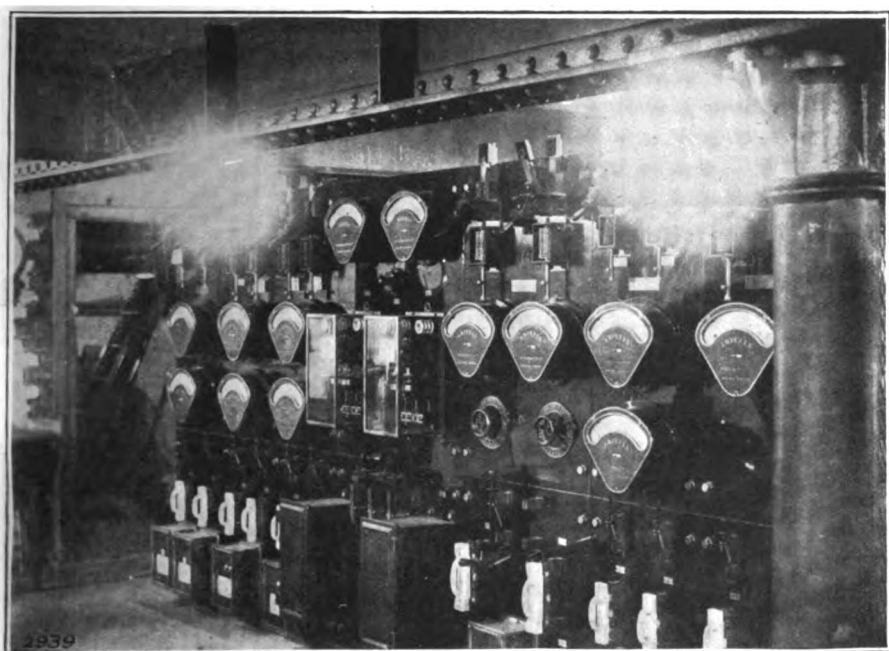
3.—THE NEW COMPRESSOR SETS.

CARDIFF POST OFFICE ELECTRICAL SUPPLY. **CONSTRUCTION**

The transfer was complicated by the difference in voltage between the old and new supplies, and necessitated re-winding about twenty motors, changing approximately 1000 incandescent lamps, replacing arc-lamps by incandescent lighting, and the diversion of all circuits to the new power-board.

The load was gradually transferred to the new supply as the work proceeded, and finally the new pneumatic sets were brought into use and the old plant shut down.

The new power board shown in 4 was supplied by Messrs.



4.—THE NEW POWER BOARD.

Spagnoletti, and comprises three lighting panels, three power panels, and a centre corporation panel.

The lighting and small motors are approximately balanced on the two sides of the system, and the lifts and main power units are run on the 400° outers.

The pneumatic sets, which were installed by Messrs. Tilghman, are of the horizontal, belt-driven type, and are very efficient. Economy has been effected by the provision of electro-pneumatically controlled cut-off valves fitted to the pressure cylinders (see 3).

The old station's record is good, failure of supply being rare and never exceeding a few minutes. It is hoped that the Corporation supply will be as reliable.



EDITORIAL NOTES AND COMMENTS.

WHEN we are called upon to pen the few words, which, quarter by quarter, constitute our editorial comments on matters past, present, and future, it is naturally our aim to seek inspiration in the direction either of some event of importance from the standpoint of the official Department of the State Service to which we owe allegiance, or of some equally notable happening in the wider world of engineering generally.

As a rule, there is no great difficulty in finding material, in spite of the fact that, in engineering, progress is of the slow and methodical order rather than the spasmodic and sensational. But on the present occasion, it must be confessed that—with a single exception in the realm of long-distance telephony—there is only one subject which, even from the particular view-point of the engineer, seems worthy of special mention, and that, of course, is the conflict in which so large a part of the old world is now engaged.

We suppose it may be said with a fair degree of accuracy that, under normal conditions, the engineer, in whatever branch of the profession he practises, is regarded as equally the symbol and the apostle of civilisation, that is of the development of all natural resources for the benefit of the whole community. It comes, therefore, as a shock to find that a careful review of the operations of the present war, and a comparison of the conditions with those of even the most modern of previous campaigns, disclose, at every turn, the overwhelming part played by the engineer in the development of means and methods of destroying life and property, and, as a natural

corollary, of measures for minimising the effect of those means and methods when employed by the enemy.

It is impossible under present conditions to attempt to indicate the degree of success or reliability which has been attained in various directions in the development of means, either of offence or defence, or of the extent to which anticipations have been realised—in some instances, definite information is available only within a narrow circle of officials or officials and manufacturers: in others, there is no particular need for secrecy in regard to the unit, but the scheme comprising all the units is of vital importance. Nevertheless, there is even now much information available to show that the calculations of the designer and the work of the experimenter have carried us far—the 15-inch naval gun has been brought into practical use, although not yet on the open sea; the armoured aeroplane has demonstrated its ability to withstand more than a little shrapnel and rifle fire; and the submarine torpedo-boat—whatever may prove to be its limitations—has taken a prominent place in the warfare of the seas.

To our readers, in particular, the arrangements for maintaining communication between the numerous units, which in the aggregate comprise our fighting forces and also our defences, are naturally of special interest, and none the less because this aspect of the naval and military situation does not achieve great prominence either in the lay or the technical press. Since the fateful day in August last, when peace vanished from Western Europe, many of our colleagues have been called upon to give of their best—some at home and others abroad—and few have escaped the additional burden that has fallen upon a service which is rather an adjunct of peace than of war. The difficulties which have had to be confronted in meeting all the demands have been accentuated by the withdrawal of many reservists for active service and also, we are proud to think, by an eagerness on the part of others to enlist which could not have been forecasted with any degree of assurance.

It is unfortunate that, at a time when the demands on the home service are so great, the elements themselves should contribute to the task—we refer to the fact that during the latter part of the winter snow and wind have worked some appreciable destruction to the overhead plant in various parts of the country, with considerable inconvenience to the community at large. It is comforting to know, however, that but for what had already been done to increase the proportion of underground plant the disturbances would have been much more serious, and, with the return of peace, we have no doubt that this necessary work will be pursued with the same vigour as before.

A GREAT ACHIEVEMENT.

In the days when the doors of the Temple of Janus are closed the aphorism that "Peace hath her victories not less renowned than War" may be appreciated, perhaps, more fully than at present, but the saying holds good, independent of the time. Every discovery in the realm of natural law, every fresh adaptation of Nature's forces to the service of man, every conquest of physical difficulties that to our fathers appeared unsurmountable forms a milestone on the path of humanity.

We have become so accustomed to the telephone nowadays that we are apt to forget how young a servant it is. On March 10th, 1876, the first audible words were spoken on the telephone: "Mr. Watson, come here, I want you." The same words were used again by Alexander Graham Bell and to the same person on Monday, January 25th last, but on this occasion the listener was 3400 miles away, instead of being in the next room to the speaker as he was thirty-nine years earlier.

Long line telephony in the United States has developed considerably since Prof. Pupin, a brilliant son of Serbia, filed his patent specifications for loading coils—the theoretical advantage of inductance in a telephone circuit had been proved years earlier by our own Oliver Heaviside—and the Telegraph and Telephone Company has tackled the problem with characteristic energy. In 1884 New York was connected telephonically with Boston, in 1893 with Chicago, in 1898 with Omaha, in 1911 with Denver, and in 1913 with Salt Lake City.

The last section of the line, from the Mormon State capital to San Francisco, has now been completed, and the engineering staff of the company has accomplished a task which but a few years ago appeared to be an impossible one. The erection of the western portion of the line was in itself no small undertaking. There were no roads and the construction gangs had to transport poles and equipment across much difficult country. Redwood poles, 8 in. square at the bottom, 4 in. square at the top, and 18 ft. long, were used mainly, and in many cases had to be planted in salt swamps and shallow lakes. A description of the circuits from the transmission standpoint is given elsewhere, but we should like to take the opportunity to offer the congratulations of our staff to the officials of the A. T. and T. Company. We are not so obsessed by the one big job now in hand by this country as to overlook and fail to appreciate a professional success by our *confrères* outside the ropes.

Three hundred and seventy additional officers have joined the forces from the Engineering Department since November 27th, drawn from the following grades :

Engineering officers	3
Chief inspectors	2
Clerical officers	56
Skilled workmen (established)	87
Skilled workmen (unestablished, labourers, etc.)	217
Other grades	5

The total number withdrawn now amounts to 4946, and 103 R.E's. from Ireland.

Commissions have been given to some half dozen officers in addition to those published in our last issue. We hope to be able to reproduce a complete list of these officers in our next number.

Our readers will note with pride the recognition of the deeds of derring-do by members of our staff at the front :

Corporal W. J. Northcote (Skilled Workman, Scotland West), Cable Coy., R.E., Territorials. Distinguished Conduct Medal.

Sergeant H. A. Tucker (Labourer, North Eastern), 2nd King's Royal Rifles. Distinguished Conduct Medal.

Lance-Corporal R. Johnson (Skilled Workman, Class II, South Wales), Signal Section, R.E. Mentioned in despatches.

Sergeant A. H. Mead (Unestablished Skilled Workman, South Western), 1st Wilts Regiment. Mentioned in despatches.

Particulars of the acts of gallantry for which the first two men have been rewarded are given under their respective District Centre Notes.

HEADQUARTERS NOTES.

TELEPHONE DEVELOPMENT.

MANUAL EXCHANGES.

WREXHAM.—A new C.B. No. 12 exchange with a fitted capacity for 480 subscribers' lines was opened on February 20th. Approximately 300 subscribers' lines were transferred.

ARGYLE (GLASGOW).—This exchange was closed on February 6th, the remainder of the subscribers' lines being transferred to Glasgow Central Exchange.

Orders have been placed for the equipment of new C.B. exchanges at :

NOTES

HEADQUARTERS NOTES.

Darlaston	108 lines.
Merthyr Tydvil	310 „
Perth	1000 „
Ryde	400 „

Orders have been placed for extending the existing equipment at :

Brixton	1500 lines.
East Ham	100 „
Hammersmith	1100 „
Hampstead	1080 „
Putney	1300 „
Sale	120 „
Sevenoaks	100 „
Sutton	800 „

Installation has been commenced at :

Darwen new exchange	520 lines.
Devonport new exchange	760 „
Romford new exchange	360 „
Wilmslow new exchange	320 „
Chiswick extension	1100 „
Hammersmith extension	1100 „
Putney extension	1300 „
Streatham extension	600 „
Sydenham extension	1400 „
Walthamstow extension	320 „
Wimbledon extension	1200 „

Installation of the following equipment has been completed :

Admiralty P.B.X.	600 lines.
Lowestoft new exchange	480 „
Bristol extension	1460 „
Derby extension	360 „
Dublin extension	1080 „
Greenwich extension	1600 „
Nelson extension	160 „
Worthing extension	300 „

AUTOMATIC EQUIPMENTS.

New orders for automatic equipment have been placed as follows :

AVENUE EXCHANGE, LONDON.—Outgoing order-wire selector equipment for twenty-five circuits to “B” positions at Avenue, Central, City, and London Wall Exchanges, to be provided by Messrs. Siemens Bros. and Co., Ltd.

CENTRALISED SERVICE OBSERVATION.—Automatic equipment at

Kingston and Richmond Exchanges for observing the service on twenty-five lines at each exchange from the existing observation desk at Putney Exchange, to be provided by Messrs. Siemens Bros. and Co., Ltd.

RURAL AUTOMATIC EXCHANGES.—Automatic exchange equipment operated from primary batteries for: (1) Twenty-five subscribers' lines and junctions to Slough at Colnbrook (Bucks). (2) Twenty subscribers' lines and junctions to Reading at Hurst (Berks). (3) Thirty subscribers' lines and junctions to Peterboro' at Ramsey (Hunts), to be provided by Messrs. Siemens Bros. and Co., Ltd.

The Accrington full automatic exchange for 700 lines, installed by the Automatic Telephone Manufacturing Company, Liverpool, was completed and brought into use on March 6th.

THIRTY portable electrically driven vacuum cleaners have recently been installed in the London exchanges, and it is hoped that the experience gained with them will justify their adoption in all exchanges except the very smallest. The successful application of vacuum cleaners for the cleaning of telephone exchange equipment is very largely a question of the design of suitable tools; the tools at present supplied are mostly experimental, but it is intended that a standard set shall be evolved when sufficient experience has been gained.

The question of design of tools is specially difficult in the case of automatic exchanges, but as the result of experiments carried out on the Official Exchange this difficulty has now been successfully met.

Experiments in connection with automatic regulation of the temperature in automatic exchanges are now in progress at the Official Exchange, and it is expected that it will be found practicable to regulate the temperature within 1° F. during the winter months, which should be of considerable assistance in preventing deposition of moisture on the apparatus.

LONDON DISTRICT NOTES.

NEW BUILDINGS IN PROGRESS.

London District Headquarters, Denman Street, London Bridge.—Satisfactory progress continues to be made with the erection of the offices for the Superintending Engineer's headquarters; the sub-basement, basement, ground floor and first floors are well advanced, and the iron work has been completed as far as the third floor.

Toll Exchange, Norwich Street, W.C.—The basement of this building has been brought into use as a school for the training of underground jointers.

Charterhouse Exchange.—Building operations on the site which has been obtained for the new 10,000 line exchange (not far from the famous “Angel” at Islington) commenced in the first week in December, 1914, and are proceeding rapidly.

GREENWICH NEW EXCHANGE.

Greenwich, a name familiar to mariners the world over, has hitherto been without a telephone exchange, a service having been provided from the neighbouring exchanges at Woolwich, New Cross, and Lee Green. On Saturday, February 27th, at 2 p.m., this defect was remedied by the opening of the new exchange building in Creed Place, adjoining Greenwich Park, and not far from the world-famed Observatory.

The building, which has been specially designed for telephone purposes, provides for an ultimate capacity of 4800 lines, and is equipped for 1600 lines. Four hundred and thirty-one were brought into service in the transfer operation :

Lee Green contributed		130
New Cross	„	239
Woolwich	„	61
Central	„	1
		—
		431

Direct junctions are provided to 25 of the principal London exchanges, the opening equipment consisting of 81 incoming junctions, 67 outgoing junctions, 18 order wires. The switchboard, which includes 15 A. positions and 8 B. positions, has been installed by the Peel-Connor Telephone Manufacturing Co.

NEW ADMIRALTY SWITCHBOARD.

The new 11-position Branch Exchange of No. 12 type, referred to in the last issue, was brought into service on March 1st.

EXCHANGE EXTENSIONS.

Avenue Exchange.—The installation of an automatic call-wire selector has been commenced at this exchange.

Hammersmith.—The extension of the equipment by 1120 lines and 138 incoming and 120 outgoing junctions, also the modification of 6 junction positions to keyless order wire working, is proceeding.

Willesden.—The extension of the equipment by 700 lines has been commenced.

Chiswick.—The extension of the equipment by 1120 lines and 60 incoming and 80 outgoing junctions has been commenced.

Paddington.—The installing of a 1000-line automatic traffic distributor is nearing completion. The conversion of 24 incoming junction positions to keyless ringing and 3 A positions to jack-ended junction positions has been commenced.

Kensington (Messrs. Derry & Toms' Private Branch Exchange).—A new 3-position private branch switchboard has been fitted and brought into use in place of the 2-position switchboard.

TRANSFER OF SUBSCRIBERS' LINES.

The work of disentangling the two networks which existed before the transfer of the National Telephone Company's plant to the State is proceeding steadily in London.

An instalment is completed in connection with each new issue of the 'Directory,' and the bulk of the work has now been completed. Hitherto, the 'London Directory' has been published in July and in January. This is now the largest printing contract in the United Kingdom, and, as it puts a serious strain on the resources of printing establishments to issue a January 'Directory' at the same time as they are dealing with the heavy Christmas trade, arrangements are in progress to shift the 'Directory' date forward so as to better regulate the load on the printing trade. The present issue took place on February 1st, and 2317 transfers of subscribers' lines from one exchange to another were included. It had been found possible by negotiating with the subscribers to carry out 1545 of these transfers in advance; the remainder, 772, were carried out successfully on February 1st.

NEW TELEPHONE LINES.

During the thirteen weeks ended January 26th, 1915:

2764 Exchange lines,
2250 Internal extensions,
243 External extensions

were fitted. In the same period:

3141 Exchange lines,
1631 Internal extensions,
169 External extensions

were recovered, making a net decrease of 377 exchange lines and net increases of 619 internal extensions and 74 external extensions. These figures illustrate strikingly one of the economic results of the

NOTES

LONDON DISTRICT NOTES.

war. Many small firms with single telephone lines have found it desirable to retrench, and have ceased their subscriptions. On the other hand, large firms with extensions have in most cases found that the war has brought them additional business, their existing telephones have been worked to the full, and it has been necessary to provide additional internal and external extensions.

EXTERNAL CONSTRUCTION.

For the three months ended January 31st, 1915, the net increase in exchange single wire mileage was 8870 miles, the increase under the head of underground being 9640 miles, whilst the open (bare wire) and open (aërial cable) decreased by 252 and 518 miles respectively. It will be seen that steady progress is being made with the removal of the ex-National Telephone Company's open routes.

Trunk wire mileage increased by 178 miles, but telegraphs (which include cable companies and press private wires) decreased by 16 miles.

Pole line mileage increased by 9 miles, while pipe lines increased by 26 miles.

The aggregate mileages for the District at the end of January, 1915, under the various services are as follows:

Route Mileage.

Pole line (bare wire)	2467
Pipe „	3326

Single Wire Mileage including Spares.

Telegraphs	21,642
Telephone exchange	939,434'5
Telephone trunks	29,278'75

Total single wire mileage . . . 990,355'25

The total length of cables in the district is 6948 miles.

AMBULANCE-CALL SYSTEM.

The City of London has possessed since 1907 an excellent police ambulance service. At fifty-two central points, street pillar-boxes are installed which communicate with a switchboard at the police headquarters. When an accident occurs, a police constable opens the box by means of a special key and summons the ambulance. Most visitors to the City have at some time or other seen the traffic

held up in response to the call of the electric gong with which the white electric ambulance carriages are equipped. Last year, no less than 2389 persons were conveyed to the City hospitals by means of these conveyances. The average time after the occurrence of an accident for the ambulance to arrive on the scene is four minutes, and the average time taken before the patient is placed in the accident receiving ward, including the time taken in rendering first aid on the spot, is only nine and a half minutes.

The activities of this excellent service are very strictly confined to the one square mile of the City proper. The London County Council, however, recognising the obvious advantages of the system, have arranged to extend it to the whole of the London county. A central switchboard has been provided at the fire-brigade headquarters, and, instead of providing expensive special call-pillars, householders and others have been approached for permission to use their telephones for ambulance purposes, a tablet notification being placed on the front of the building intimating that the ambulance service may be called therefrom. The services of the ambulance may now be obtained from any telephone connected with the public service, and the benefits of the system are thus greatly extended at a very small cost. The new service was inaugurated at the beginning of February.

REMOVAL OF ENGINEER-IN-CHIEF'S RESEARCH SECTION.

The branch of the Engineer-in-Chief's research laboratory, till recently accommodated at Telephone House, was removed to more commodious premises on the fourth floor, King Edward Building, early in the new year. The new premises are constructed with a view to ample protection from fire. The accumulators for power purposes are situated in an outhouse upon the roof. The following voltages are available for experimental purposes: 2, 4, 6, 8, 10, 20, 24, 30, 40, 48, 110, and 230.

The whole of the wiring, both main and subsidiary, has been carried out with lead-covered cable placed in iron racking. Various cabinets for transmission tests have been provided. A junction switchboard, providing leads to the various experimental benches and cabinets, and a battery board capable of supplying power to the same have been equipped. Standard 8-pr. cable to the extent of 10·15 miles is also being provided, together with a specially designed switch for giving various combinations of lengths of standard cable. The leads to the standard cable will be carried up a ventilation shaft from twenty half-mile drums located in the basement. A connecting experimental cable will also be provided to the Engineer-in-Chief's research section at G.P.O. (W.).

CENTRAL TELEGRAPH OFFICE.

Western Electric multiplex has now been fitted in the provincial gallery and is being worked experimentally to Manchester.

Phonogram Room.—Londoners are steadily acquiring the telephone habit, and the phonogram room, where telegrams are received over the telephone, now has sixty-six receiving stalls. Some months ago a new system of signalling was brought into use whereby the C.T.O. stall operator cleared to the distant exchange, and the clear signal was given to the C.T.O. concentrator on the withdrawal of the plug by the exchange operator. This system is now being altered, and the stall operator will clear to the concentrator and the distant exchange.

Stock Exchange.—In anticipation of the early commencement of re-building of the Threadneedle Street B.O. (Stock Exchange), two rooms in an adjacent building have been equipped as telegraph instrument rooms, and fully wired, ready for the temporary accommodation of all the Stock Exchange circuits during the re-building.

Extensive alterations to the street tubes which carry the telegraphic traffic from this office to the C.T.O. have also been undertaken, and a system of house tubes installed.

THE SNOWSTORMS.

The serious damage caused by the snowstorms have eclipsed, in interest, all other matters, but this is being dealt with fully elsewhere.

COUNCIL NOTES.

A MEETING of the Council was held in London at the Institution of Electrical Engineers, Victoria Embankment, on January 27th, 1915. All the members (with the exception of Mr. H. Cranage, who is performing military duties) were present.

The usual Autumn Meeting of the Council had to be abandoned owing to the war, and the members had not met since June 9th 1914.

The Secretary reported that in almost all centres great difficulty had been experienced in providing programmes of meetings this session, and in four cases, owing to pressure of work, depletion of staff, etc., due to the war, it had not been possible to arrange any meetings. It was satisfactory to note that in the majority of cases

the motto, "Business as usual," had been acted upon with excellent results.

PRESIDENT'S AWARD COMPETITION.—Owing to the abnormal conditions prevailing, it was decided not to ask the President to renew his generous offer to award prizes for essays on engineering and clerical subjects this session.

TECHNICAL JOURNALS.—It would appear from the replies received to inquiries that the present system of circulating technical journals is satisfactory, and also that in the absence of any suitable alternative the members desire the continuance of the same.

PAPERS RECOMMENDED FOR PRINTING.

The following papers are to be printed and will be issued as soon as possible:

"Power Plant for Pneumatic Tubes in Post Office," by A. B. Eason.

"Procedure in Connection with the Negotiation and Treatment of Wayleaves," by A. J. W. Dauncey.

"The Preparation of Underground Schemes," by A. Rattue.

"Private Branch Exchanges," by Messrs. D. H. Kennedy and J. W. Turner.

Several papers are under consideration and will be reported upon later.

ANNUAL REPORT.—Local secretaries are reminded that details of meetings held during the present session, the results of the election of officers for the ensuing year, and financial report and balance-sheet for each centre should be in the hands of the Secretary by March 31st or very early in April.

T. SMERDEN,
Secretary.

LOCAL CENTRE NOTES.

NORTH-EASTERN CENTRE.

THE session to date has been a successful one.

At our first meeting in October, the chairman of the local branch of the institution, Mr. T. B. Johnson, gave a most interesting paper on the "Past, Present, and Future of the Engineering Department," dividing his remarks in the four heads—telephony, telegraphy, allied services, and staff.

At the November meeting, Mr. Tanner's paper on "Building Materials used by the Post Office Engineering Department" dealt with a phase of departmental work which had hitherto not been brought before the notice of the local members of the institution, and proved helpful, whilst Mr. Pickering's paper on "Devolution and its Effects," in December, cleared up many points.

Mr. Wolstenholme was to have been the lecturer at the January meeting, but, as he had obtained a commission in the Durham Light Infantry, Mr. Ray, of Carlisle, took his place, and delivered a paper on "Notes on Aërial Construction," which was illustrated by means of lantern slides, showing many difficult jobs which had come under his notice.

In February a special meeting was held so that the members of the institution might have the opportunity of hearing Mr. Renshaw deliver his paper on the "Ethics of Supervision," and all who have read that paper in the last number of the JOURNAL will readily understand that a lively discussion followed, which enabled the members to state fully their opinions, and it was interesting to note the different ideas of the essentials of supervision held by the members.

The attendance throughout the session has been well maintained.

ON ACTIVE SERVICE.

The members of the North-Eastern District are proud of one of their colleagues—Sergeant Tucker—whose conduct at Kleinzonnebeke was briefly referred to in the 'Post Office Circular' of the 9th February. The feat which Tucker performed, and for which he has been granted the Distinguished Conduct Medal, is all the more meritorious when the full circumstances are known. It was not carried out at a time when "a wild, mad rush" was being made, but when, with the knowledge of his senior officer's wishes, the predicament the whole of his company was placed in, and the quick decision made in the interests of his comrades, that Tucker coolly carried out his dangerous task.

* * *

A company of the 2nd King's Royal Rifles—Tucker was a private—occupied a trench at Kleinzonnebeke opposite a German trench, separated by fifty yards. The Germans placed a machine gun in position, and in a few minutes the company of the 2nd King's Royal Rifles would have been at the mercy of the Germans if the gun had not been put out of action. Tucker was asked by his lieutenant if he would volunteer to put the gun out of action, and although, as he modestly states, the job was not to his liking, he picked up a trenching tool, went into the open, and, covered by his

comrades' rifles, knocked the emplacement from under the gun and returned. His chagrin may readily be imagined when, on his return, he learned that the lieutenant was not satisfied with the work done, and that it was considered that the gun was as great a menace as ever! A second time he crossed the fifty yards, and, making certain of his work, caused the gun to roll over, so that it could not be replaced by the Germans without exposing themselves to the fire of the 2nd King's Royal Rifles. Tucker returned safely.



SERGEANT H. A. TUCKER, D.C.M.

He was promoted a corporal, then a sergeant, and is now—a hero.

Since the incident described above, Tucker was blown out of a trench at La Bassee on New Year's Day, and, as a result, has been suffering from nervous shock, but it is pleasing to record that he is recovering.

SCOTLAND WEST CENTRE.

The first meeting of the session was held on January 15th, 1915, when a paper was read by Mr. A. Jacquest on "Testing and Balancing of Underground Cables which are required for Super-imposed Telephone Working."

The lecturer gave a short description of the theory underlying the tests, and then described, in more detail, the actual operations which are carried out in order to balance, so far as possible, at each selected joint. The actual apparatus which is being used on the Glasgow-Paisley and Glasgow-Edinburgh cables was on view, and the practical arrangements described. A short description was also given of the tests for differential resistance and cross talk.

The local branch are much indebted to Mr. Jaquest for kindly preparing lantern slides and giving his paper and a practical



CORPORAL W. J. NORTHCOTE, D.C.M.

demonstration of the work involved in this new branch of cable balancing.

Corporal W. J. Northcote, Cable Company, Royal Engineers (Territorials), a skilled workman from Glasgow Post Office, has been awarded the Distinguished Conduct Medal for repairing a telegraph line on November 21st under shell fire after it had been destroyed by German shells. Two of the Worcesters were killed and three wounded in proximity to the line. Corporal Northcote has done continued good work since he went to the front, and, it is claimed, is the first Territorial to receive the D.C.M. For that reason his comrades at the front are proud of him, as letters to friends in Glasgow testify, and we are sure all at home will heartily agree with the sentiment.

NORTH WALES CENTRE.

The first opportunity is taken to amplify the somewhat incomplete information regarding the work of the North Wales Centre, contained in the Institution Annual Report for the session 1913-14.

As shown by the list of papers given below, the session was a most successful one, and the large attendance of members, as well as the animated and well-sustained discussion at each meeting, indicated the real interest felt in the proceedings by the district staff.

Unfortunately, the location of the headquarters at a non-industrial centre like Shrewsbury reduces the opportunities for visiting works, and no visits of this character were made during the year.

1913.

October 29th.—“ Ineffective Time.” N. F. Cave-Brown-Cave.

1914.

January 28th.—“ Machine Switching in Telephony.” B. O. Anson.

February 25th.—“ Procedure in Connection with the Negotiation and Treatment of Wayleaves.” A. J. W. Dauncey.

March 31st.—“ The Recruiting and Training of the Department's Workmen.” J. Caradoc-Jones.

May 12th.—“ Faults and Maintenance.” E. J. Jarrett.

The current year's programme is also well filled, bearing in mind the exceptional conditions in which the Engineering Department is placed by the present national crisis.

1914.

November 17th.—“ New System of Fault Records for Local Exchanges.” T. Plummer.

December 15th.—“ Economics and Development.” W. Burbridge.

1915.

February 14th.—“ Notes on the Desiccation of Paper Insulated Cables and Design of the Air Pump.” J. Caradoc Jones.

March —.—“ Telephone Transmission.” H. P. Lloyd.

NORTHERN CENTRE.

The second meeting of the Northern Centre was held on January 5th, when Mr. A. Scott, of the Scotland East District, read a paper on “ Wireless Telegraphy.” The paper was excellently illustrated by a number of lantern slides. The thanks of the members of the local centre are due to Mr. Scott for having so kindly consented to read his paper whilst visiting Newcastle on holidays.

The opportunity is also taken of thanking Mr. A. S. Renshaw for reading his paper on the "Ethics of Supervision" during his visit to this district. A profitable discussion followed the reading of the paper, and Mr. Renshaw is to be congratulated on the manner in which he placed the ethical views of supervision before his hearers.

Mr. C. E. Pollock and Mr. R. D. S. Norman, both members of the local centre, have been given commissions as second lieutenants in the Signal Section of the Royal Engineers. Both of these gentlemen served through the Boer War. Lieut. Norman has been serving in one of the signalling units at Aldershot since October, and has only recently received his promotion. Lieut. Pollock, who left the district at the beginning of February, is now on active service with a signalling unit.

BOOK REVIEWS.

'Automatic Telephony: A Comprehensive Treatise on Automatic and Semi-Automatic Systems,' by Arthur Bessey Smith, E.E., and Wilson Lee Campbell, E.E. (The McGraw-Hill Book Coy., 6, Bouverie Street., London, E.C. 17s.)

In the early days of the development of automatic telephony in the United States, practically the only printed information available on the subject, on this side of the Atlantic, was contained in certain pamphlets bearing the names of the writers of the above volume. Prior to 1908, the installation of automatic telephone equipment was almost entirely carried out by the "independent" companies, and while it was in the interests of these companies that the claims of the automatic systems to superiority should be bruited abroad, it did not follow that the publication of detailed descriptions of the mechanisms and circuits would be to their advantage. In these latter days, however, the literature on the subject has grown apace, and, incidentally, it is not claiming too much to say that this JOURNAL has done more than any other periodical to spread the knowledge of the various systems. The articles by Messrs. W. J. Bailey, R. Lawson, J. Hedley, and others, which have appeared in our pages, have been widely read throughout the world, and from all parts appreciatory notices have been received.

Our descriptions have, however, appeared at intervals, as the British Post Office installed the exchanges, and the necessity had arisen for a text-book on the subject which would combine within its covers a comprehensive study of the systems as they are now in operation, so that the telephone engineer may compare readily the methods and efficiencies of the several plants. Such a text-book is now before us. The authors have done their work in an exhaustive fashion. Detailed descriptions are given of the Automatic Electric Company's switchboard apparatus and system, of the American Automatic Telephone Company's plant, the Siemens and Halske system, the Lorimer, the Clement automatic arrangement, the Western Electric Company's semi-automatic and automatic systems. Chapters are also devoted to traffic distribution schemes, power plant, traffic and development studies.

The plates and diagrams are clear, and the printing and binding are of the best quality. The volume is one that every telephone expert should have at hand, if he wishes to keep in touch with the extraordinary development which has taken place in machine switching in the last half-dozen years.

'The Universal Electrical Directory' (J. A. Berly's), 1915. (Messrs. Alabaster, Gatehouse and Co., 4, Ludgate Hill, E.C.)

The importance of the electrical industry is illustrated in a very marked fashion by the fact that in this year's edition of the above there are no fewer than 35,390 names of firms engaged in the manufacture or distribution of electrical material.

In spite of its bulk, however, there is no confusion in the compilation, the sections being subdivided into alphabetical and classified parts, a thumb index indicating where each section may be found. Telegraphic addresses, telephone numbers, and financial particulars of limited liability companies are given, and in the list of supply undertakings full particulars of the capacity and character of the plant are quoted. In the British Section a list of specialities appears, together with the necessary information as to where they can be obtained. The edition maintains its character for accuracy, and should be invaluable to the electrical trade generally. Price £1 1s. *od.*, post free; the "A" edition, which omits the Continental and U.S.A. sections, 12s. *od.*, also post free.

LIBRARY NOTES.

The following books have been added to the Library, and are available for issue to members:

- No.
529. 'Handbook of Technical Instructions for Wireless Telegraphists.' J. C. Hawkhead.
530. 'C.B. Telephone System.' W. Atkins.
531. 'Automatic Telephony.' A. B. Smith and W. L. Campbell.
532. 'Instruction in Army Telegraphy and Telephony.' Vol. I. Instruments.
533. " " " " Vol. II. Lines.
NEW EDITION.
228. 'Engineers' Year Book,' 1915. H. R. Kempe.

ROLL OF HONOUR.

WE sincerely regret to announce the deaths of the following men killed in action, who were drawn from our Department for active service. Second List. (N) Navy. (A) Army.

Name.	Rank.	District.
A. G. Adams (N) . .	Labourer	S. Mid.
H. Alcock (N) . .	"	London
J. F. Allison (N) . .	"	Scot. E.
R. J. Anderson (A) . .	"	N.W.
J. Ashbrook (A) . .	"	S. Lancs.
A. Barfield (A) . .	"	N. Mid.
H. Barnard (A) . .	"	S. Mid.
S. E. Barnden (A) . .	Unest. Skilled Workman	E.
H. W. Barnes (A) . .	Labourer	"

ROLL OF HONOUR

ROLL OF HONOUR.

Name.	Rank.	District.
H. Barnett (A)	Unest. Skilled Workman	N. Mid.
W. J. Betts (A)	Labourer	E.
D. Carney (A)	Skilled Workman, Cl. II.	Scot. E.
F. Clark (A)	Labourer	N. Mid.
C. Clarke (A)	"	S. Wa.
H. J. Clarke (A)	"	N. Mid.
P. A. Coe (A)	"	E.
E. W. Cole (A)	"	S. Mid.
W. Cunningham (A)	"	N. Mid.
J. Edgell (A)	Unest. Skilled Workman	S. Mid.
J. Fitzgerald (A)	Labourer	N. Wa.
B. W. Girard (A)	Skilled Workman	S. Lancs.
C. R. Goakes (A)	Labourer	N. Mid.
S. J. Green (A)	Skilled Workman	N.W.
B. Hopkins (A)	Labourer	E.
R. Horton (A)	"	N.E.
W. E. Hughes (N)	"	S.E.
P. H. James (N)	Unest. Skilled Workman	London
E. J. Jones (A)	Labourer	S. Lancs.
M. King (A)	"	N.
J. Leitch (A)	Boy	Scot. E.
R. H. Marsden (A)	Labourer	S.W.
H. Miller (N)	"	S. Wa.
F. C. Morgan (A)	"	S. Mid.
G. J. Morris (N)	Unest. Skilled Workman	London
H. E. Norvill (A)	" " "	S. Wa.
E. R. Ponsford (A).	Labourer	S. Mid.
A. C. Royal (N)	"	"
M. Scully (A)	"	Ireland.
J. J. T. Skinner (A)	"	S.E.
G. Smith (A)	"	S.W.
James Smith (A)	Unest. Skilled Workman	Scot. W.
C. Stearman (A)	"	N.
F. C. Stubbs (A)	Labourer	London
W. Swanson (A)	"	Scott E.
A. Whitehead (A)	"	London
S. O. Wilson (N)	"	S. Mid.
A. E. Woodbine (A)	"	E.
W. G. Workman (A)	Skilled Workman	S. Wa.
A. Young (A)	Labourer	S. Lancs.

STAFF CHANGES.

STAFF

STAFF CHANGES.

POST OFFICE ENGINEERING DEPARTMENT.

PROMOTIONS.

Name.	From.	To.	Date.
Thow, J. H.	Exec. Engr., London	Asst. Suptg. Engr. Provinces	To be fixed later.
Dickson, J.	Asst. Engr., S. Lanes. Dist.	Exec. Engr.,	3 : 1 : 15
France, G. S.	Asst. Engr., N. Wales Dist.	Exec. Engr., Ireland (Cork Section)	To be fixed later
Brown, J.	Asst. Engr., Scot. E. Dist.	Exec. Engr., Scot. E. (Dundee Section)	"
Wilby, E. J.	Asst. Engr., E. in C.O.	Exec. Engr., Ireland (Dublin City Section)	"
Steed, H. P.	Asst. Engr., London	Exec. Engr., London (C.T.O. Section)	"
Flavel, G. H.	Chief Navg. Officer, "Alert"	Chief Navg. Officer, "Monarch"	"
Firmin, E. W.	2nd Navg. Officer, "Monarch"	Chief Navg. Officer, "Alert"	"
Skilliter, C.	2nd Navg. Officer, "Alert"	2nd Navg. Officer, "Monarch"	"

RETIREMENT.

Name.	Rank.	District.	Date.
Broadbridge, A. J. W.	Chief Navg. Officer	"Monarch"	18 : 12 : 14

TRANSFERS.

Name.	Rank.	Transferred from.	To.	Date.
Jefferyes, G. C.	Exec. Engr.	Scot. E.	Ireland	—
Spottiswoode, D.	3rd Cl. Clerk	E. in C.O.	Surveyors' Dept. as Asst. Surveyor, Cl. 2	2 : 3 : 15
Ashton, W. N.	Chief Inspector	North Western Dist.	Traffic Branch as Contract Officer, Cl. 1	1 : 3 : 15

DEATH.

Name.	Rank.	District.	Date.
Barnett, W. E.	3rd Cl. Clerk	E. in C.O.	26 : 12 : 14

NOTICES

EDITORIAL NOTICES.

BOARD OF EDITORS.

T. F. PURVES, M.I.E.E., Chairman.	J. W. ATKINSON, A.M.I.E.E.
A. W. MARTIN, A.M.I.E.E.	A. O. GIBBON, A.M.I.E.E.
A. C. BOOTH.	W. T. HARRIS.
W. CRUICKSHANK, A.M.I.E.E., Managing Editor.	

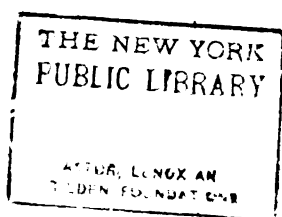
COMMUNICATIONS.

All Remittances and Communications should be addressed to the MANAGING EDITOR, P.O.E.E. JOURNAL, Engineer-in-Chief's Office, G.P.O. West, London, E.C.

A few copies of Part 1, Vol. 1, and Part 1, vol. 7, of the JOURNAL are required by the Board. Full price will be paid for copies in good condition, or another part can be sent in exchange. The JOURNALS may be sent to the Managing Editor direct, or through the local agents.

Binding covers and copies of the Contents Index for Vol. 7 are now available, and may be obtained from the local agents for 1s. and 2d. respectively. Subscribers can have their copies bound, with index included, at a cost of 1s. 9d., by sending the JOURNALS to the local agents. Orders should indicate whether the original binding covers, or the later pattern, are required.

A supply of the first instalment of the Station List of Engineering Officers eligible for membership of the Institution, issued with the last April number of the JOURNAL, and including all officers down to Assistant Engineers, is in stock, and copies can be obtained on demand, price 3d. each.





SIR WILLIAM SLINGO, ENGINEER-IN-CHIEF, G.P.O.



HONOUR BESTOWED UPON THE ENGINEER- IN-CHIEF OF THE BRITISH POST OFFICE.

THE inclusion of the name of the Engineer-in-Chief of the General Post Office in the list of Birthday Honours recently promulgated has given great satisfaction in the Engineering Department of the Post Office in particular, and among the engineering profession generally, and we take this opportunity of expressing our gratification.

Sir William Slingo is the third Engineer-in-Chief whose services have been recognised by the bestowal of the honour of knighthood. Sir William Preece and Sir John Gavey were honoured in this manner in 1899 and 1907 respectively, but it has fallen to the lot of Sir William Slingo to have the distinction of being the first Engineer-in-Chief of the British Post Office to be made a Knight while in official harness.

An outline of the career of Sir William Slingo was furnished in our issue of April, 1912. In that number it was stated that "Mr. Slingo has taken up the reins of government in the great Engineering Department of the Post Office at what is probably the most critical period in its history." The period was critical because the Engineering Department was engaged at that time in the stupendous tasks of transferring the National Telephone Company's plant to Post Office control, preparing the inventory of and valuing that plant, preparing evidence for the arbitration proceedings relative to the price to be paid by the Government for the Company's system, and fusing the National Telephone Company's engineering staff with the Post Office staff. The leading part taken by Sir William Slingo at the arbitration proceedings mentioned will be remembered, and it may be safely assumed that his services in that connection con-

HONOUR HONOUR BESTOWED UPON THE ENGINEER-IN-CHIEF.

tributed very materially to the reduction of the Company's claim, which amounted to £20,924,700, while the amount awarded by the Commissioners was £12,515,264.

In 1913, Mr. Slingo gave evidence for the Department before the Holt Parliamentary Committee and before the Committees of both Houses of Parliament which dealt with the Post Office (London) Railway Scheme. Another outstanding feature of the work done by the Engineering Department in that year was the laying of the Anglo-Irish (loaded) Telephone Cable—the longest submarine telephone cable in the world—by the Department's cable ship, "Monarch."

In 1914, Mr. Slingo served on no less than six important Committees, including the Committee on State Research in Wireless Telegraphy (presided over by the Rt. Hon. C. E. H. Hobhouse, M.P., and subsequently by the Rt. Hon. Lord Parker of Waddington); the Committee on High Speed Telegraphy (presided over by Captain Norton, M.P.); the Imperial Wireless Committee (presided over by Sir Alexander King, K.C.B.); the Telephone Finance Committee (presided over by Sir Alexander King, K.C.B.); the Electric Mains Explosions Committee (presided over by Sir T. Edward Thorpe, C.B., F.R.S.); and the Telephone Rates Committee (Chairman: Sir Alexander King, K.C.B.).

At March 31st, 1914, the prime cost value of the telegraph and telephone plant under the responsibility of the Post Office Engineer-in-Chief was over thirty-seven million pounds; and in the financial years 1913-14 and 1914-15 the expenditure under the control of the Engineer-in-Chief was five and three quarter million pounds and six and a half million pounds respectively.

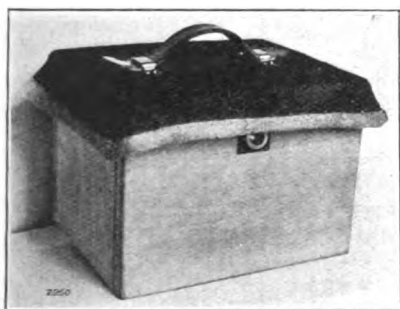
Since the outbreak of the war in August last, the duties of the Engineer-in-Chief have been exceptionally onerous, particularly in connection with communication services, and it is interesting to note that out of a total staff of 25,350 officers and men, the Engineer-in-Chief has released no less than 6,000 (or 23 per cent.) for service with the naval and military forces.

This brief *resumé* of the activities and responsibilities of the Engineer-in-Chief of the British Post Office furnishes no cause for wonder that His Majesty has seen fit to recognise the public services rendered by the present head of the Engineering Department, whose distinguished official career began with his appointment as a telegraph clerk at the Central Telegraph Office, London, so long ago as 1870.

Sir William and Lady Slingo's innumerable friends and admirers wish them many years of happiness, and confidently anticipate that further honours will be bestowed upon them.

TRENCH TELEPHONES.

IN designing light portable telephones such as those used for military communications at or near the fighting line it is necessary to make a fairly large sacrifice of signalling and speaking efficiency in order that the size and weight of the instruments may be reduced to a minimum. Operations such as those in which our army is now engaged appeared, however, to offer a field for apparatus of a semi-portable nature, and this consideration led the Post Office to design and place at the disposal of the War Department a type of telephone providing first grade speaking and ringing facilities, and, at the same time, capable of ready transportation from point to point. The mobile operations of the army are well served by the existing field service sets (telephone and buzzer) used for communication, by light



Front.

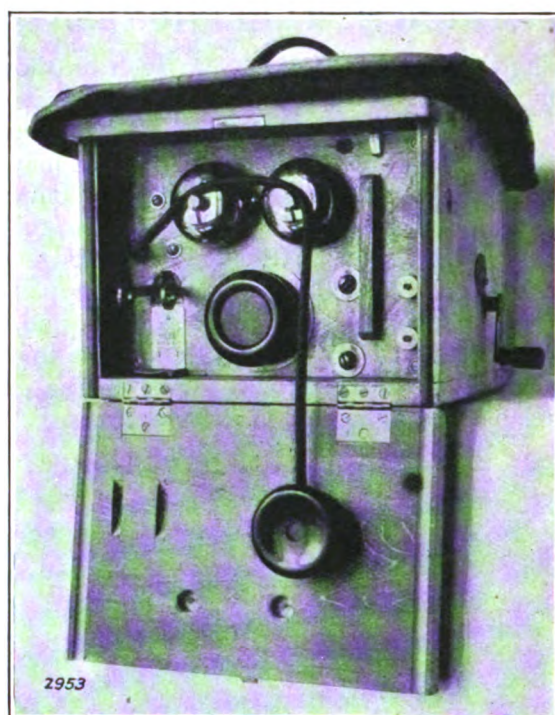


Back.

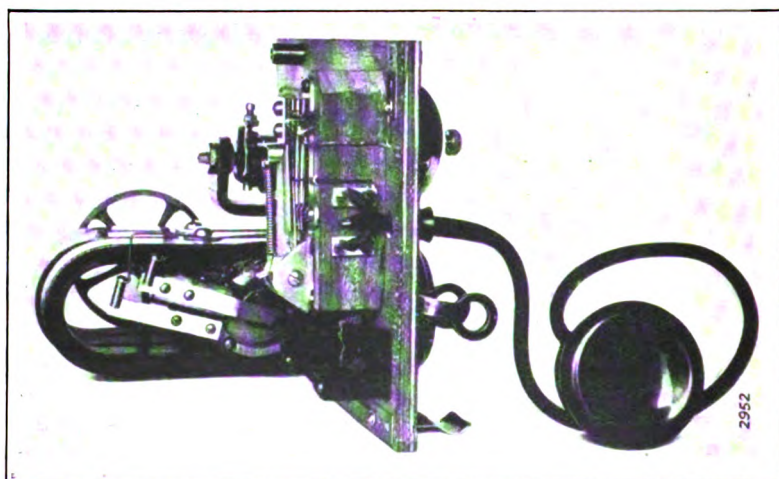
I.—TRENCH TELEPHONE.

cables or insulated wire, between batteries and observation points, and for connecting points in the advanced lines of trenches with one another and with the headquarters of battalions and brigades. The instrument here described was not intended for such work, but for the longer and more permanent connections established between the various headquarters and comparatively settled strong-posts and entrenchments, as well as for the scattered offices of the staff and administration officers of brigades and divisions, which have constantly to be moved from town to town and from village to village.

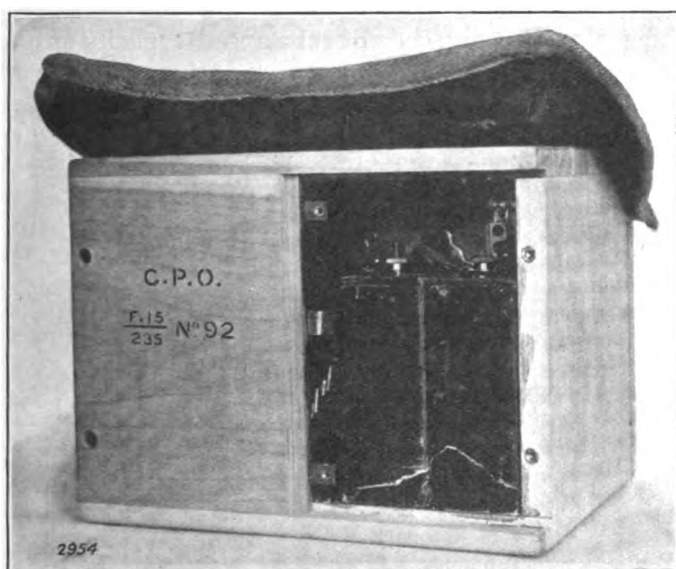
The first type supplied was made up by utilising bell boxes recovered from old pattern National Telephone Company's magneto telephones, of which several thousands are in stock. These comprise a powerful three-magnet generator, a good magneto bell, an induction coil, and a switch-hook. When fitted with a transmitter case, adapted to take the standard form of primary battery "capsule" transmitter, and furnished with a modern bell receiver, they represent a compact form of magneto telephone of full standard



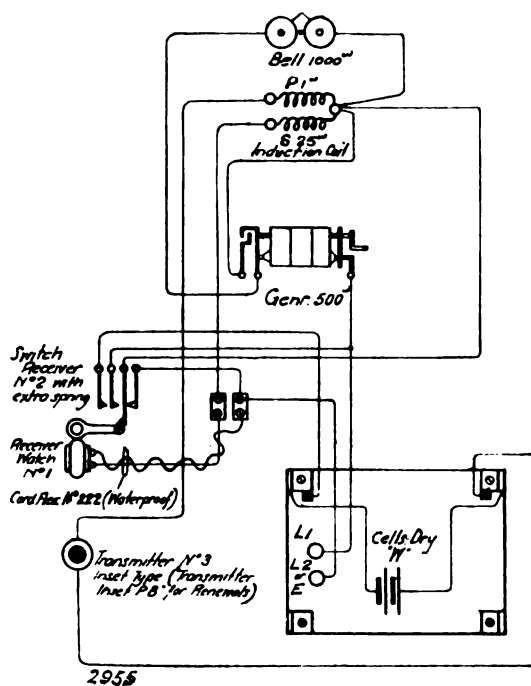
2.—FRONT VIEW: HINGED FRONT OPEN.



3.—REMOVABLE PANEL CARRYING APPARATUS.

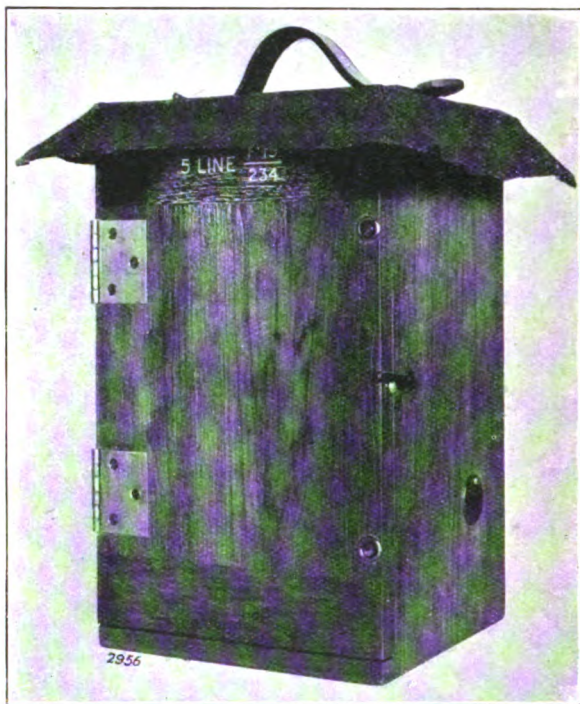


4.—BACK PANEL REMOVED FOR ACCESS TO CELLS.



5.—CIRCUIT CONNECTIONS.

efficiency. The whole was enclosed in a strong wooden case, containing also two dry cells of substantial capacity as a speaking battery, with a leather carrying handle, thus producing a self-contained telephone which could be carried about, without any packing, in ammunition waggons and other forms of rough transport without suffering damage, and could be used at need in quite unsheltered positions. Their stock title is "Telephone No. 92 (Mark 234)." No Post Office instrument could possibly work



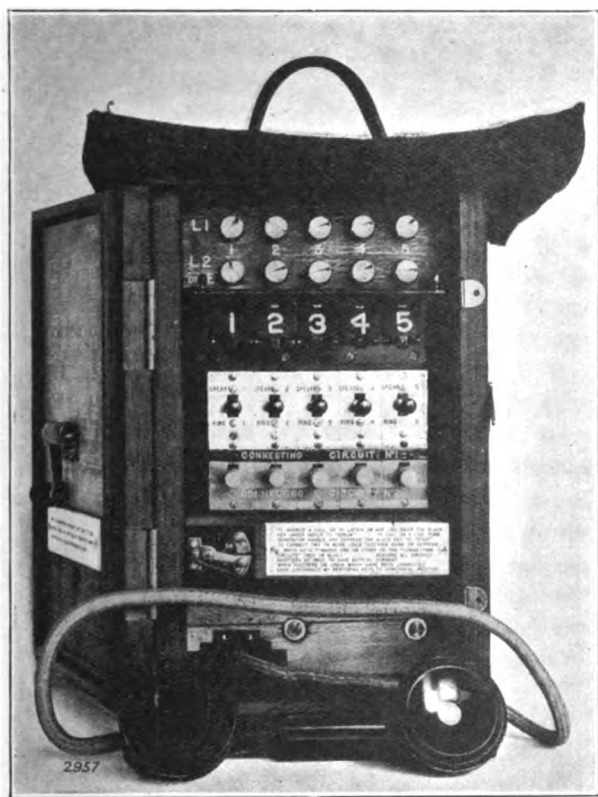
6.—SWITCHBOARD, CORDLESS, 5-LINE, PORTABLE.

satisfactorily without a proper stock title! Considerable numbers were supplied to the British Expeditionary Force in France. They are also being used in England by the Admiralty in the equipment of Royal Naval Air Service motor waggons carrying anti-aircraft guns and searchlights, and by the military authorities for special home defence communication lines.

Their weight is about 26 lb., and although, for the purposes in view, small size and lightness were no great considerations, it was recognised that they were unnecessarily cumbrous, and another form, shown in 1 and 2, was designed. This form is known as "Telephone No. 92 (Mark 235)," and its weight is about 13 lbs. A watch

receiver, which has very nearly the same efficiency as a bell receiver, is used, with the Department's "Cord No. 222," waterproof, cut to half length and enclosed in a thin rubber tube. Otherwise, the apparatus it comprises is identical with that of the "Mark 234" type.

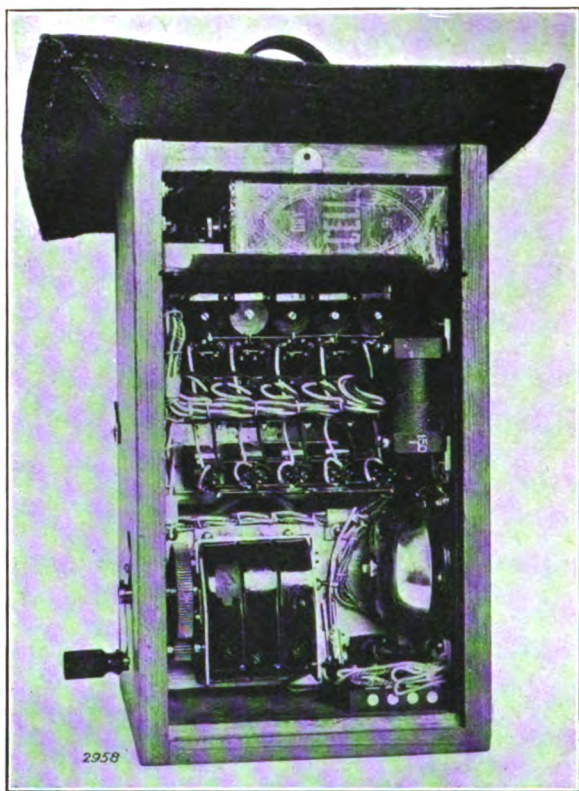
All the parts, except the two speaking cells, are assembled on a tablet of three-ply wood, which, by the removal of four screws, can



7.—5-LINE SWITCHBOARD. FRONT OPEN.

be taken right out of the case, when every part is directly accessible for inspection or repair (see 3). Two of the screws are made to carry the battery connections, so that it is not necessary to touch any of the internal wires when withdrawing the apparatus tablet. The battery can be got at independently by removing a portion of the back (see 4). The hinged front cannot be closed unless the receiver has first been replaced in its proper position under the movable switch-hook; this ensures that the speaking battery is disconnected and the bell joined in circuit ready to receive a call at all times when the instrument is not open for use.

The top is covered with the brown waterproofed sailcloth used for Post Office tents, shaped to drop slightly all round as a rain shield, which can be turned back out of the way when not required. The illustrations shown were made from photographs of a white wood sample, but the colour of the finished telephones is the orthodox khaki. When used in the field they are hung by the handle from a wooden spike driven into the wall of the trench, or a

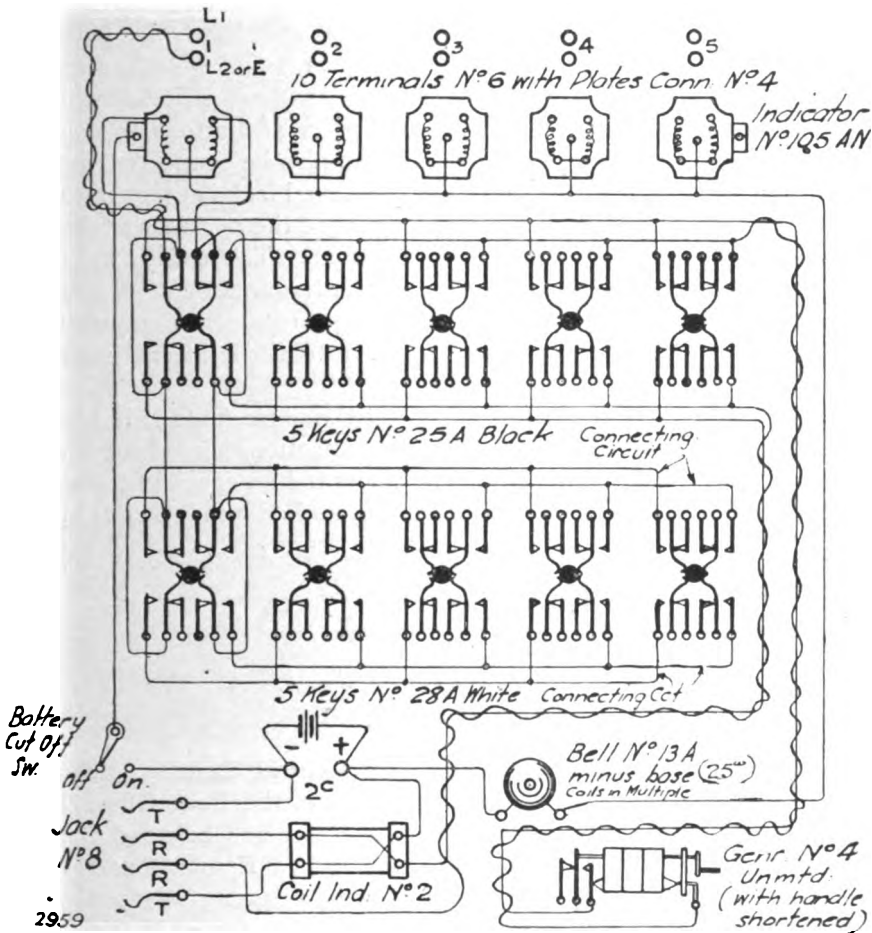


8.—5-LINE SWITCHBOARD WITH BACK REMOVED.

small rectangular recess may be cut with a spade to accommodate them. The electrical connections are shown in 5. A copy of this diagram is pasted on the inside of the hinged front of each telephone, and a second copy is pasted inside the removable back panel which shuts in the speaking cells. Large numbers of the "Mark 235" instruments have been made up in the Post Office factory and sent to the British army in France, and weekly consignments are still being forwarded.

Self-contained portable magneto switchboards on the "cordless" principle have also been made up from Post Office stock apparatus,

and are being supplied for the use of the army. A view of an unpainted sample 5-line switchboard is shown in 6. Views of the internal apparatus, front and back, are shown in 7 and 8, and the electrical connections are shown in 9. The lines enter through the roof, under the sail-cloth cover, and are taken to strong screw



9.—5-LINE SWITCHBOARD. CIRCUIT CONNECTIONS.

terminals, the slots of which are made big enough to allow a penny or other coin to be used as a screwdriver. A row of keys, with black knobs, under the drop indicators, provides for speaking and ringing on any line. The lower row (white knobs) is for through switching purposes. There are two connecting circuits, symbolically denoted on the keys by broad painted lines of red and blue. Two or more keys turned simultaneously toward either of these coloured lines will connect the corresponding circuits together. Two pairs of stations

can thus converse independently, or any number of stations may be bunched together for simultaneous communication. A hinged metal strip fitted above the indicators keeps the line wires from dropping down in front of the shutters and can also be turned down against the shutters in order to prevent them from being shaken down and damaged during transportation. The hand-combination telephone used is the War Office "Telephone, hand, D, Mark 3," connected to a Post Office 4-pin plug and jack; 10-line switchboards are made up in a similar manner, and are provided with two rows of switching keys, allowing four pairs of stations to converse independently. The remaining pair can also be connected together if necessary by turning the corresponding black keys in the upper row to the speaking position; in this case the operator's telephone remains in circuit during the conversation. The calling indicators serve also as clearing signals; when the termination of a conversation is indicated by the dropping of the shutters the connection is severed by restoring the switching keys to their normal horizontal position.

For larger offices the ordinary Post Office magneto switchboards, 20-line and 30-line, are supplied. All connections are led out to screw terminals, and the switchboards are mounted on special floor stands, made in two positions hinged together, and adapted to shut up and serve as packing cases for transport purposes.

T. F. PURVES.

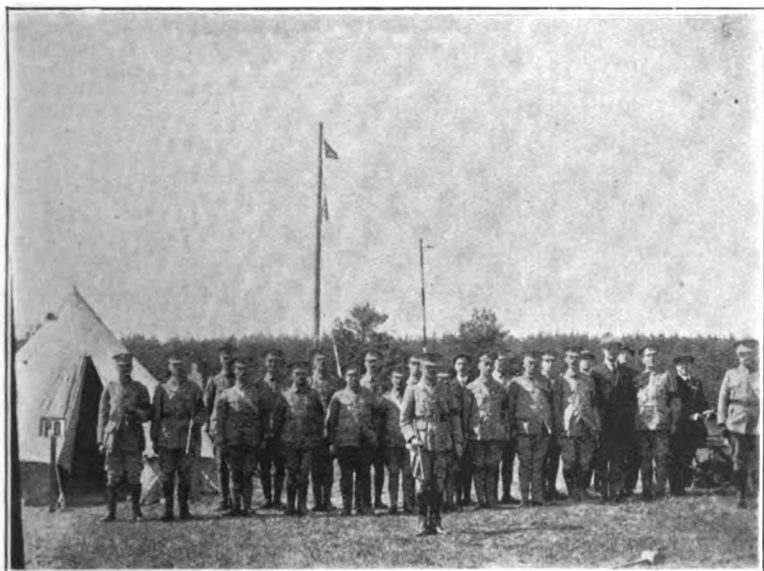
POST OFFICE ENGINEERS' V.T.C. WHITSUN CAMP.

THE "Architects" (4th Battalion Central London Regiment V.T.C.) having invited the co-operation of the Post Office Engineering Corps, a detachment joined the Camp at Chelwood Gate for the Whit week-end. Company Commanders Kennedy and Watts with four men formed our contingent of a strong advance party, who, on the Thursday, Friday, and Saturday prepared the Camp. They had a very busy and strenuous time, and, under markedly competent guidance, produced a fully-equipped camp complete in all details, even to a flag-staff, the flag on which could be seen for miles. There were also a very useful bathing-place as well as a swimming-pool.

Commandant Gunton, accompanied by Sub-Commandant Stubbs, arrived at Camp on Saturday morning, the rest of the detachment, including Quartermaster Parsons with the line stores, arriving later in the afternoon under Company Commander Watts, who had returned to London in order to take charge. Half-Company Com-

mander Edmonds also accompanied the detachment; and, as Commandant Gunton returned to London the same day in order to take charge of the Whit Monday operations on Epsom Downs, there were thus five officers of Engineers. The detachment in camp numbered five N.C.Os. and twenty men.

On Saturday evening the Camp was put into telegraphic communication with Chelwood Gate Post Office, and the Officer commanding—Sub-Commandant C. Stanley Peach, of the "Architects"—sent the first message to our Commandant. Thirty messages were sent during the two days. About 200 letters and a few parcels were



I.—THE DETACHMENT. POST OFFICE, POST AND TELEGRAPH FLAGSTAFF, AND TERMINAL POLE IN BACKGROUND.

dealt with at the Post Office. The Post Office was also the ambulance headquarters—the camp doctor was a private in the ranks of the "Architects."

Commandant Gunton got into touch on Saturday afternoon with the Brigade Headquarters of a large camp (two regiments) of the South-Western Division of Mounted Infantry, one result being that on Sunday morning we erected a telephone cable circuit from the Brigade Headquarters towards Forest Row. Captain Ranson of the Signal Troop warmly welcomed our co-operation, and it is possible that shortly we may provide a detachment to assist in some night operations with the troops.

On Sunday evening we engaged in a very instructive reconnaissance with the "Architects." The operation involved taking the whole

"party" (about 150) through fairly exposed country and deploying them with a view to preventing the enemy scouts (six members of a Company of the Bucks Volunteer Defence Force, a few of whom joined the Camp) from breaking through. This was accomplished without the scouts getting a glimpse of a single man—a performance which involved carrying planks to cross streams and a considerable tramp in a water-logged ditch. The Engineers also provided telephonic communication between the pickets. The operations were completely successful. In spite of great resourcefulness



2.—THE PIONEER PARTY CARRYING PINE BRANCHES FOR CAMP BEDS.

five out of the six enemy scouts were captured, and were marched back to share a supper of hot soup with their captors!

On Monday we marched out and captured Camp Hill—an operation that would take several weeks if attempted by several thousands of our troops in France! During these operations our Flag Signallers; working with the Architects, kept the corps continuously in touch with the Camp. Subsequently we inspected several of the adjacent Crowborough trenches, and then back to Camp by devious ways—good route march practice.

Two of our officers and seven N.C.O.s and men stayed on Monday night to clear up the Camp, and the remainder marched back to Forest Row and returned by train, all feeling that such experiences as they had had at Chelwood Gate raised our *esprit de corps*, and increased our efficiency in a degree that could scarcely be

looked for from Hyde Park drill or London route-marches. We now want a summer camp—and are going to have one.

A. J. S.

FIRE ALARM CIRCUITS IN P.O. BUILDINGS.

THE slow growth of an installation, telegraphic, telephonic, or both combined, from comparatively small beginnings to the dignity of bigness, lends itself to the incorporation of many features that Time in its wisdom condemns, and, as in the case of the disastrous fire at the Gutenberg Exchange in Paris on the evening of Sunday, September 20th, 1908, this condemnation occasionally takes the form of a fearful holocaust, at any rate so far as material is concerned. The lesson of the Paris Exchange fire is the same lesson that is to be derived from all the outbreaks of fire, large and small, within the experience of the Department, to wit, the elimination of the "inflammable."

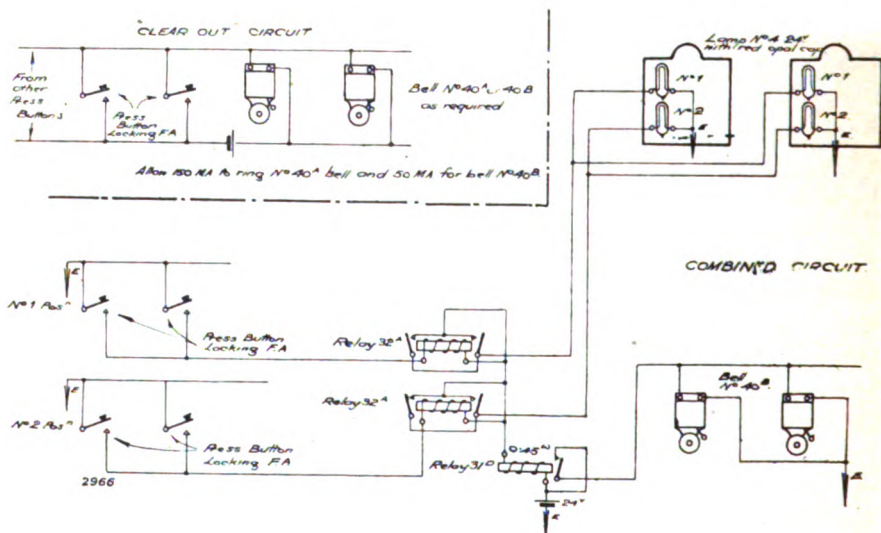
The work of eliminating the "inflammable" in the case of existing buildings, as distinguished from new buildings designed and wired in accordance with the latest fire-resisting methods of construction, has been going on quietly and effectively for years, and it is a source of satisfaction to have assurances that everything possible is being done in order to reduce the fire risks in buildings in which otherwise there might be danger to life in the event of a conflagration occurring.

Since Sunday, September 20th, 1908, much progress has been made, not only in respect of improving the fire-resisting properties of wiring and other materials, but also in the design of buildings, in which telephone and telegraph plant is to be installed, and it may safely be affirmed that the possibility of a conflagration arising in a building designed in accordance with modern practice, is more remote than it has been in the past. Until Science brings to light a combination of materials by means of which fire will automatically extinguish itself, it will be necessary to have systems of fire-alarm circuits in order that when an outbreak occurs the maximum of assistance may be available in the minimum of time. With the existing arrangements, apart from accidents, fires can only develop into conflagrations through lack of vigilance on the part of the officers in the buildings.

At the present time it is somewhat difficult to place telephone exchanges in a different class from other post-office buildings, as the cases in which postal, telegraph, and telephone equipments are housed within the same walls are numerous, and in all probability

FIRE ALARM FIRE ALARM CIRCUITS IN P.O. BUILDINGS.

the number will further increase. Post office buildings may therefore be classified, for the purpose of the consideration of the question of installing fire-alarm circuits, under three main heads. The first class comprises those buildings in which no difficulty would be experienced in quickly making all members of the staff aware of an outbreak of fire, and in which, therefore, it is not necessary to instal fire-alarm circuits. The second class of building is that in which either a simple "clear-out" signal, or a clear-out system with indicators—defined as the "combined circuit"—should be installed. In arriving at a system that would satisfy the widely different conditions to be met with in buildings so classified, the main considera-



tion which determined the decision in favour of the simple system was the question of the safety of the staff. The clear-out signal in this case, it should be noted, is also the signal for a fire-drill.

From the following diagram of the simple "clear-out" circuit, it will be seen that when any press-button is operated, all the "clear-out" bells ring. Under the most favourable circumstances one press-button and one bell on the landing or stairway of each floor should prove sufficient, in order that everyone in the building may hear the loud-toned bells provided.

The combined circuit may be defined as that arrangement by means of which the operation of a press-button indicates at different points in the building the locality of the press-button operated, and at the same time rings all the fire-alarm bells in the building. If, therefore, a press-button, located near an outbreak of fire, be operated, the locality of the fire is indicated on the lamp indicator boards fitted at different parts of the building, a great advantage in a

building of three or more floors. As in the case of the simple clear-out circuit the operation of a press-button is both a "clear-out" and a fire-drill signal.

One indicator board, two press-buttons, and two bells per floor should meet the requirements where the conditions are favourable to the loud-sounding bells being heard from landings or stairways. There may, however, be circumstances in which the requirements are in excess of this, but it is suggested that a multiplicity of press-buttons and bells may tend to cause confusion.

In the third class of building to be mentioned are included certain large buildings in London in which firemen are in constant attendance. A description of one of these installations appeared in this JOURNAL in 1911. The system so described, with the addition of a clear-out signal, constitutes what is known as a double system, which comprises both a preliminary and a clear-out signal.

In connection with the wiring of all classes of internal fire-alarm circuits, attention should perhaps be drawn to the advisability of separating, if possible, the fire-alarm circuits from the general equipment, as it is not difficult to conceive a case in which an outbreak of fire would render the fire-alarm signal inoperative.

J. L. T.



332

CITY TELEPHONE EXCHANGE POWER PLANT, LONDON.

THE power plant at the City Telephone Exchange has recently been re-arranged, and the illustration is a view of the switchboard.

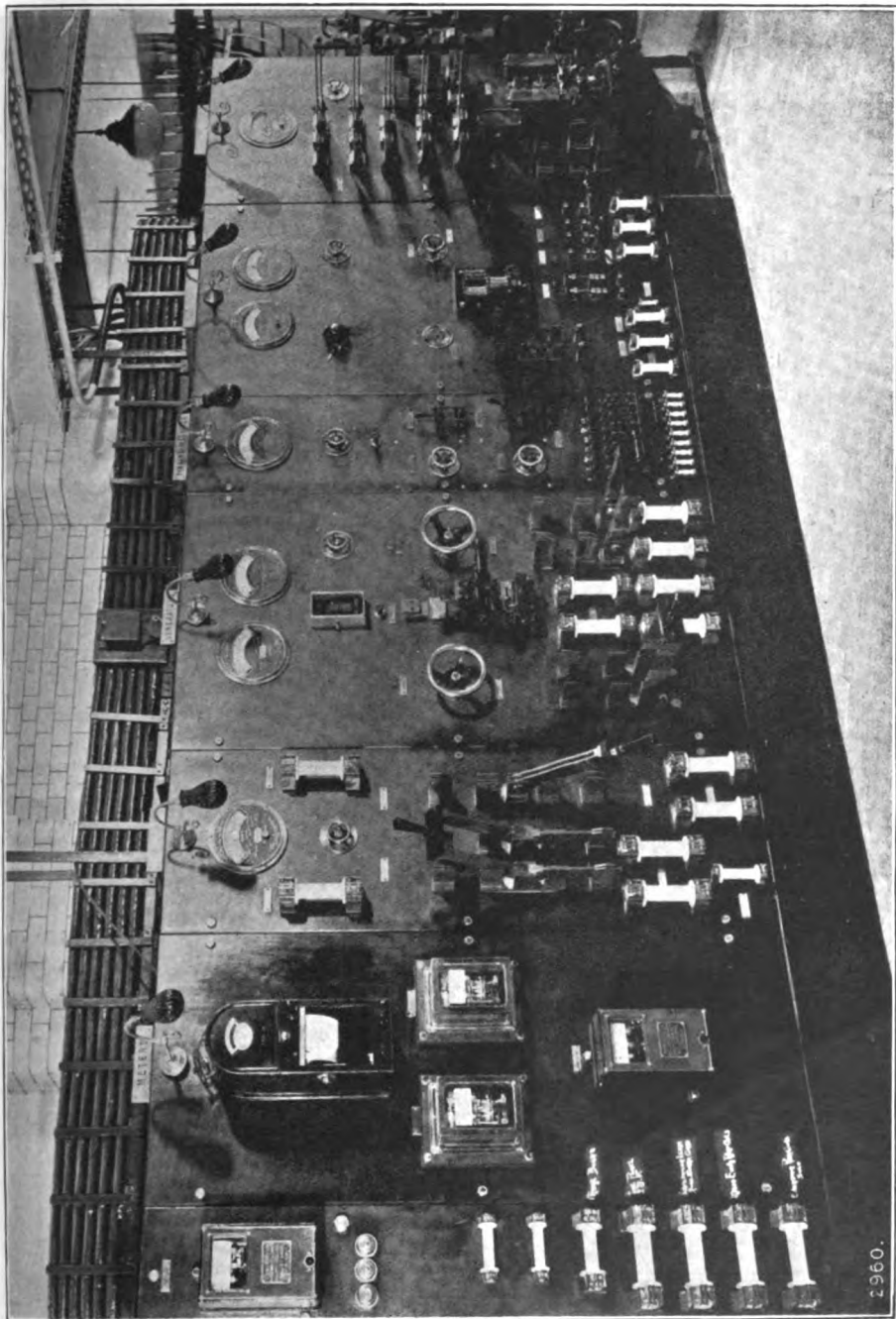
The City, Central, and Trunk Telephone Exchanges are all located in the same building at Carter Lane, E.C., and each exchange has a separate power installation. The main object of the recent re-arrangement was to increase the inter-communication facilities of the three power plants. At the same time the City Exchange power switchboard was moved forward 18 in., so that the work of inspection and repairs at the rear could be carried out more easily.

In addition to the switchboard shown there are two main switchboards and a number of smaller boards in the building.

There are two generator units at the City Exchange, each comprising a 25-horse-power motor coupled direct to a 500-ampère 30-volt generator. The switches and connections of one of the generators are of 1000 ampères capacity, so that, when necessary, the existing generator can be replaced by a larger machine. The starting boxes of the motors cannot be seen in the illustration as they are fitted away from the switchboard. These starters are of the ratchet type, and are, therefore, to some extent foolproof. Adjacent to the power board are two ringing machines for supplying the City Exchange with ringing and interrupted currents, and two smaller machines for supplying ringing current to the Trunk Exchange.

One motor-generator, with an output of 30 ampères at 42 volts, is provided for charging the City Exchange meter and Trunk Exchange signalling batteries. The switches are so arranged that in the event of the failure of this machine the trunk batteries could be charged by one of the 500-ampère generators, and the meter battery by the Central Exchange meter battery charging set.

There is one battery in use at the City Exchange, the number of plates in each cell being seventy-seven, and the capacity 5500



CITY TELEPHONE EXCHANGE POWER BOARD.

TELEPHONES TERMINATION OF LOADED TRUNK CABLES.

ampère-hours. In the same battery room there is a spare set of tanks, which would accommodate a similar number of plates. There are also a 30-volt meter battery of 180 ampère-hours, and two trunk signalling batteries, each of 120 ampère-hours capacity. The Trunk Exchange power board is at right angles to the City Exchange power board, and cannot be seen in the illustration.

The Central Exchange power plant is situated in the basement of the same building, but in a different wing. The appearance of the power board is very similar to that illustrated. There is one generator with a rated output of 1000 ampères at 30 volts, two batteries each of 3500 ampère-hours capacity, and one meter battery of 180 ampère-hours capacity. Two ringing machines are provided, each of which has a capacity of 4 ampères at 75 volts.

The switches shown on the right of the illustration are for the purpose of effecting connections between the various machines and batteries which supply the City and Central Exchanges. In the event of a complete breakdown of the charging machines or batteries in either the City or Central Exchanges, it would be possible to supply both exchanges with current from the remaining installation.

In addition to the foregoing the power plant in the building includes apparatus for three electrically driven pneumatic house-tube systems, the most interesting of which was fully described by Mr. H. P. Brown in vol. iv of this JOURNAL, and two desiccating plants with capacities of 60 and 48 cubic feet respectively of free air per minute.

Our readers will be interested to learn that during the peak of the load the current flowing to the exchanges frequently exceeds 1100 ampères. This is always a matter of surprise to power engineers who visit the building, and who think of telephone installations in terms of milliamperes.

TERMINATION OF LOADED TRUNK TELEPHONE CABLES.

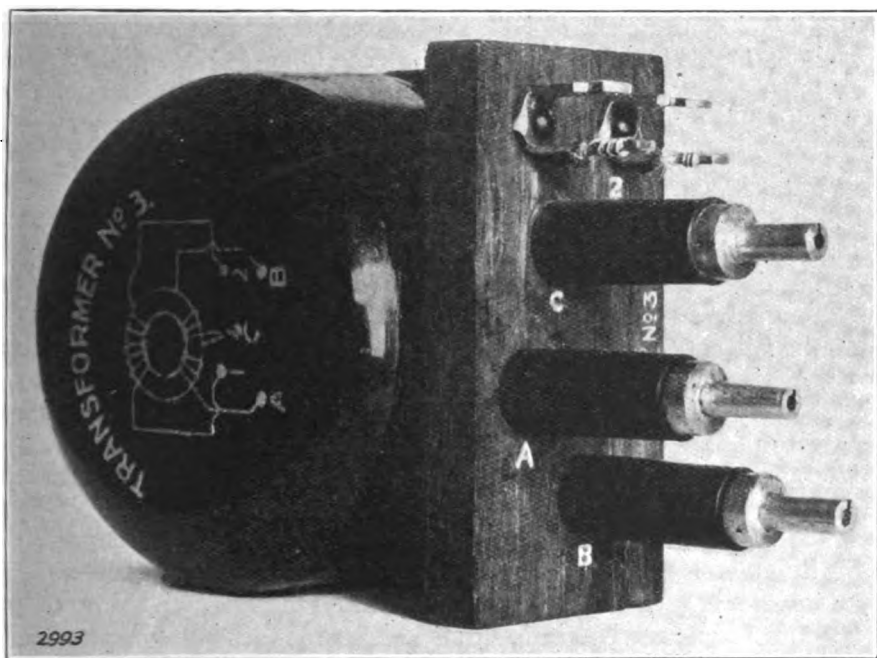
THE important loaded telephone cable now practically completed between London and Liverpool, *via* Birmingham, was described by Mr. W. J. Hilyer in Part I, Vol. 7, of this JOURNAL (April, 1914), and a description by Mr. Pollock of the method of balancing such cables was commenced in the same number. The London-Liverpool cable contains 104 conductors, as follows:

4	.	.	.	.	.	300 lb. multiple twin.
28	.	.	.	.	.	200
24	..	.	.	.	.	150
48	.	.	.	.	.	100

TERMINATION OF LOADED TRUNK CABLES. **TELEPHONES**

All the loops are loaded, and the 200 lb. and 150 lb. loops are also fitted with loading coils for superimposed working; thirteen loaded phantom circuits can therefore be formed on these loops, and thirteen unloaded phantom circuits on the remaining loops.

If such a cable were terminated upon an ordinary test-frame or upon ordinary telephone transformers, the high insulation and freedom from cross-talk obtained at heavy cost by the careful construction and handling of the cable and loading coils would be impaired by leakage between the connection tags and indoor wiring,



I.—“TRANSFORMER No. 3,” SHOWING TERMINAL PILLARS.

and by capacity unbalance in the windings of ordinary transformers. It was therefore necessary to design special terminal fittings for the cable at London, Birmingham, and Liverpool. It is decided that every pair shall be terminated upon a special transformer, whether it be, at the outset, used for superimposing purposes or not. The phantom circuits will also be worked through transformers, and the whole cable will be operated by magneto signalling. There is thus no physical connection between the cable conductors and the leads which continue the circuits to the exchange apparatus, and it is possible by providing transformers having well-insulated terminals on the cable side to ensure a high degree of insulation on the whole of the cable system proper.

TELEPHONES TERMINATION OF LOADED TRUNK CABLES.

The special transformers, which are known as "Transformers No. 3" (see 1 and 2) are electrically similar to the Western Electric Company's toroidal repeating coil, No. 4006 A, the windings of which are arranged in a special symmetrical manner devised by the Post Office, but have to pass a more exacting test for balance and insulation. The coil winding which is connected to the cable side is led to terminals mounted on stout ebonite pillars "A" and "B," and its centre, for the phantom circuit connection, if any, is led to a similar terminal "C." The second winding, which is connected through the ordinary incoming line positions of the test and distributing frames of the exchange to the switchboard, does not require the same high degree of insulation and is terminated on ordinary soldering tags, "1" and "2," on the wooden base of the transformer. The base is of well-seasoned teak, boiled in paraffin-wax after manufacture. The finished transformers are required to pass the following electrical tests:

NO. 1: TEST FOR WINDING.—The connections for this test are shown in 3. A single dry cell is connected, through a key, to terminals 1 and 2. Terminals A-C and B-C are connected in turn to a galvanometer "G," and on depressing the key the "throws" on the galvanometer should be in opposite directions for the coils compared. A similar test is made with terminals A-C connected to the battery and B-C and 1-2 connected in turn to the galvanometer; 1 to the same terminal as B and 2 to the same terminal as C. The "throws" on the galvanometer should now also be in opposite directions for the coils compared.

NO. 2.—Measurement of the difference between the capacities of the two halves of the winding A-B to the winding 1-2. The apparatus used is an alternating current bridge consisting of 5000 ohms non-reactive ratio arms, and two variable air condensers. Current is supplied to this bridge from a "howler" through a balanced and screened transformer. Before making a measurement on the repeating coils it is necessary to balance the two variable air condensers, as shown in 4. Condenser No. 1 is set in the middle of the scale, and a balance is obtained by varying condenser No. 2 until absolute silence exists in the receiver. The bridge is then joined up, as shown in 5, and a balance is obtained by varying condenser No. 1. The reading on condenser No. 1 will then be a measure of the out of balance of capacity between the two halves of the primary and secondary windings, and this should not exceed 10 micro-microfarads.

NO. 3: EFFECTIVE RESISTANCE BALANCE.—For test of effective resistance balance the terminals are connected as shown in 6. With 50·05 ω non-reactive ratio arms balance must be obtained on the slide wire between two points ·025 ω from the centre of the

TERMINATION OF LOADED TRUNK CABLES. TELEPHONES

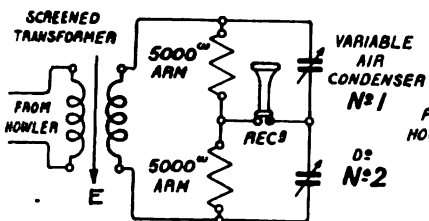


FIG 4

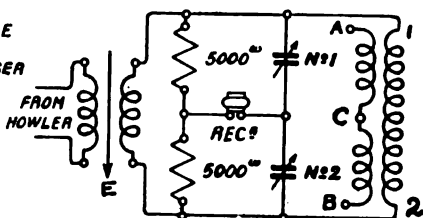


FIG 5

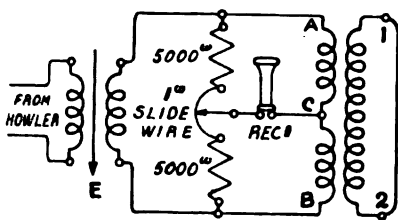


FIG 6

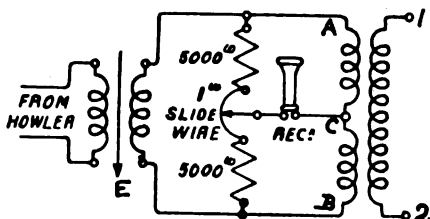


FIG 7

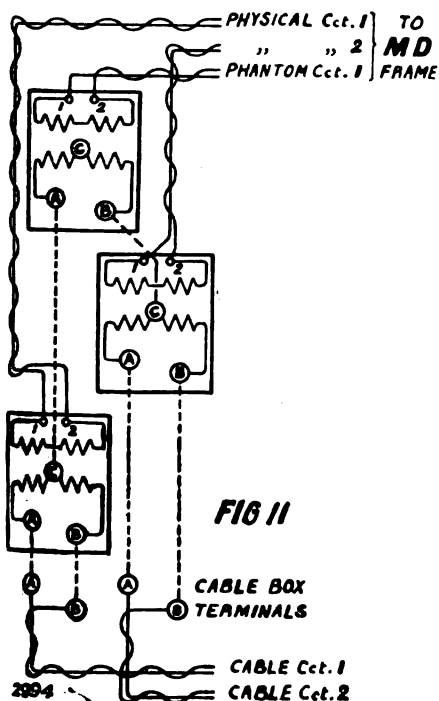


FIG 11

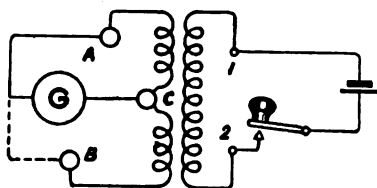


FIG 3

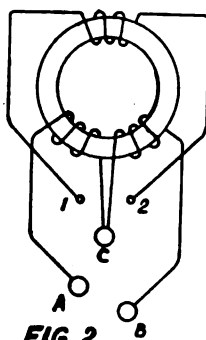


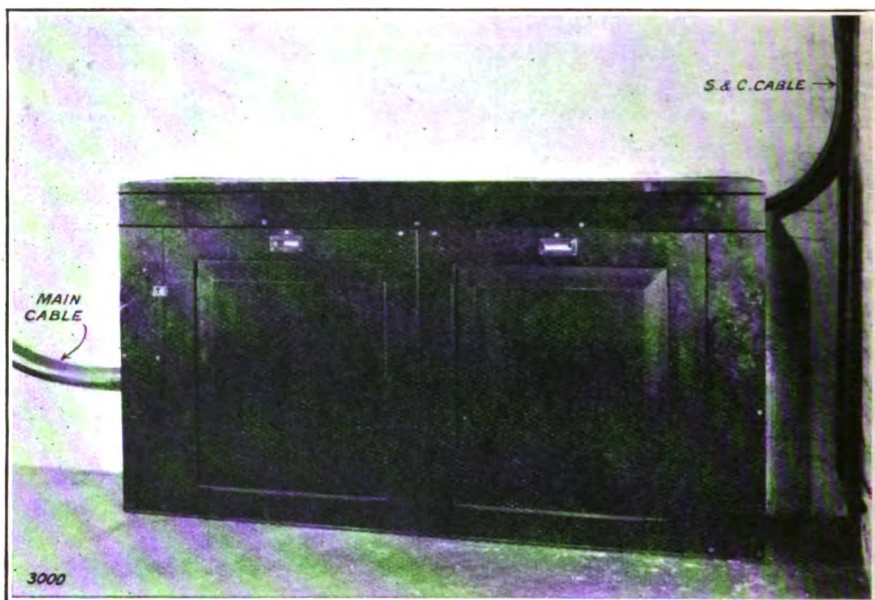
FIG 2

- 2.—INTERNAL CONNECTIONS OF TRANSFORMER.
- 3.—TEST FOR DIRECTION OF WINDING.
- 4.—METHOD OF BALANCING AIR CONDENSERS.
- 5.—TEST FOR CAPACITY BALANCE.
- 6.—TEST FOR EFFECTIVE RESISTANCE BALANCE.
- 7.—TEST FOR IMPEDANCE BALANCE.
- II.—CONNECTIONS OF TWO LOOPS AND PHANTOM CIRCUIT.

scale. This is equivalent to a ratio between the limits of 1'001 and '999.

NO. 4: IMPEDANCE BALANCE.—For the test of impedance balance the terminals are connected as shown in 7. With 5000'05" non-reactive ratio arms balance must be obtained on the slide wire between the same limits as in Test 3. This is equivalent to a ratio between the limits of 1'00001 and '99999.

NO. 5: POWER EFFICIENCY.—The power efficiency is tested with a sine form alternating current at two frequencies, such that



8.—TRANSFORMER RACK, CLOSED.

$2\pi n = 100$ and 5000. The test at the lower frequency is made with 80 volts impressed upon either the winding $A-B$ or 1-2, whilst a non-reactive load of 1000 ohms is connected across the other winding. The efficiency under this condition, and when the windings are interchanged, must be not less than 55 per cent. The test at the higher frequency is made under similar conditions, except that the testing current is 1 milliamperè, and the efficiency must not be less than 80 per cent.

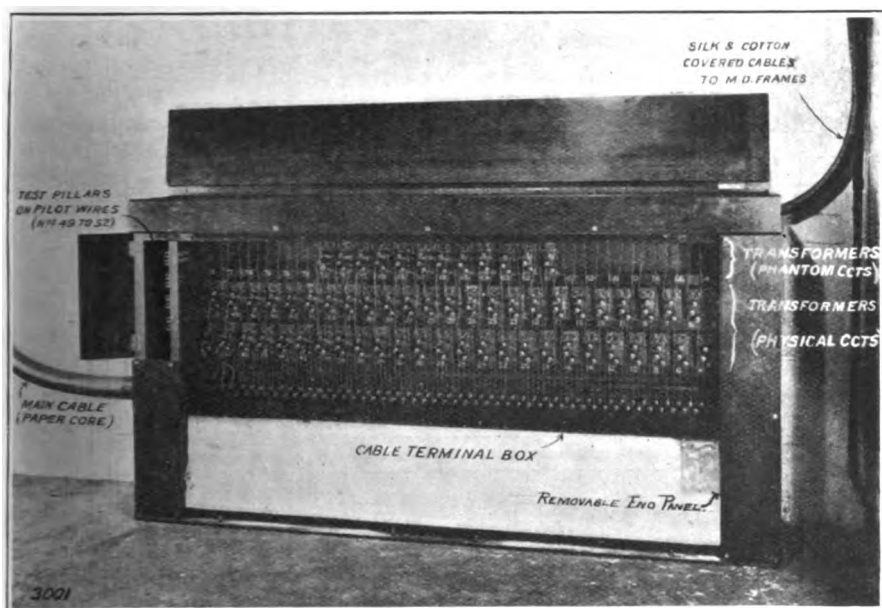
NO. 6: INSULATION.—The D.C. insulation between the windings $A-B$ and 1-2, tested from the terminals of the completed instrument, must not be less than 100 megohms when tested with 100 volts.

A special combined cable terminal box and transformer rack was designed for the point of junction between the external paper-

TERMINATION OF LOADED TRUNK CABLES. **TELEPHONES**

insulated cable and the internal silk and cotton covered cable (see 8 and 9). The relative positions of the fittings are shown by a part elevation and section at 10. 11 shows the connections of two loops and a phantom circuit formed upon them.

The terminal box, which is fitted against the wall of the test room, is made of iron plate on an angle-iron frame and contains the end of the main cable, fanned out in one continuous "form" and soldered to the inner ends of brass connectors moulded into strong ebonite pillars, screwed through the front of the box. Before the

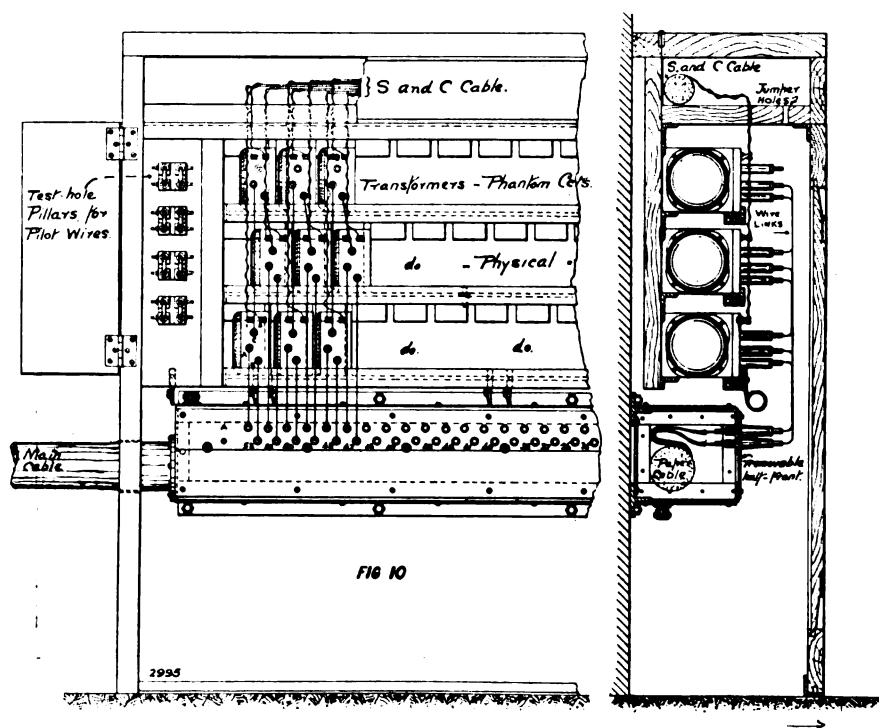


9.—TRANSFORMER RACK, OPEN, SHOWING CABLE TERMINAL BOX AND TRANSFORMERS.

cable is laced out its end is dipped in molten beeswax, and after the connection of its conductors to the pillars has been completed the cover is secured in position and the interior of the box is thoroughly dried out by connecting the desiccator for two or three hours to the air-nozzle provided in the bottom of the box. At the other end of the box a second air-nozzle is provided on the cover for the attachment of a vent tube. The box is then warmed up with spirit lamps placed beneath it, and is filled with a special grade of insulating compound known as "Service compound." The compound is poured into a filler fitted on a vertical flexible tube about 6 ft. high and enters the box through the lower air-nozzle. A second tube from the second air-nozzle on the cover leads the overflow back to the compound-heating tank. The circulation of hot compound

TELEPHONES TERMINATION OF LOADED TRUNK CABLES.

through the box is continued for about half an hour in order to make certain that all occluded air-pockets have been cleared out. The discharge tube is then raised to the same height as the filler tube, and the compound in the box is allowed to cool and solidify under the slight pressure of the "head" (about 6 ft.) provided by the compound in the two tubes, after which the tubes are removed and the caps of the air-nozzles are screwed on. When the cable end has thus been sealed and completed the transformer rack is placed in



10.—TRANSFORMER RACK. PART ELEVATION AND SECTION.

position over it. The transformers are simply laid in position on the shelves and are retained by slots and studs in the ironwork which engage their wood bases. Those on the two lower shelves are for the physical circuits and those on the top shelf are for the phantom circuits. Connections from cable to coil, and from coil to coil, are made by links of 100 lb. bare copper wire, turned over at the ends and soldered into the insulated pillar connections. The silk and cotton covered cable leading from the transformer rack to the main distribution frame is accommodated in the upper boxing of the transformer rack, and its twin pairs pass through spaced fanning holes leading directly downwards to the soldering tabs of each transformer. The fanned-out ends are beeswaxed as usual.

In order that a check may be maintained upon the condition of the insulation of the cable, without opening the main shutters of the rack or disturbing the soldered connections, the last of the 100 lb. quads, and the quad at the side of the cable opposite to the last, are led out as pilot wires through four "testhole pillars" with "U" links fitted behind a small hinged door at one end of the rack (see 9 and 10). These circuits, instead of being linked direct from the connection pillars of the cable terminal box to those of the transformers, are taken *via* the testhole pillars, by means of No. 18 V.I.R. leads, and can thus be disconnected at any time to make a test.

At Birmingham the London and Liverpool sides of the cable are terminated in two separate boxes and transformer racks, which stand close together, end to end, and are made right- and left-handed in order that all cables may enter from the outer ends. Circuits which pass permanently through from London to Liverpool are taken direct from the terminals of one cable box to the other by means of jumper wires of twin No. 18 V.I.R. wire, passing straight up through a special row of holes into the upper boxing of the racks, and dropping down to the corresponding pillars on the other terminal box. There are, of course, no transformers on the shelves above such through-connected pairs.

When the transformer rack has once been fitted over a cable terminal box it is not possible to remove the lid of the box to obtain access to the interior. The lower portion of the front of the box immediately below the terminal pillars has, therefore, been made removable. Should it ever be found necessary to get at the interior, say, to reconnect a pillar in place of a broken one, the procedure will be as follows:

Warm the box by means of a row of spirit lamps, drain off the compound through the lower air-nozzle, and take off the removable half of the front. Cut the cable conductor from the rear end of the broken pillar and draw its end down clear of the box—slack for this purpose is left when wiring the box (see 10). Unscrew the pillar and screw in a new one, to the rear end of which a short length of stout insulated conductor has been soldered. Draw the end of this also downwards through the open front and joint it to the cable conductor. Push the joint carefully back into the interior and replace the front cover. Dry out and warm the box, and refill with compound in the same manner as when first installed. The construction of the rack is such that access to the air-nozzle in the cover of the box can be obtained from above, for the purpose of connecting the flexible discharge tube as already described.

T. F. PURVES.

AN EARLY CABLE EXPERIMENT.

BETWEEN the years 1880-1890, owing to the growing demand for insulating material for covering underground telegraphic and telephonic wires, and to the increasing cost of gutta-percha, inventors were considering the question of substitutes for the latter material, which was at that time practically the only one suitable for the purpose. Various substances were tried from time to time, among others vulcanised I.R., "balata," S.P.D. (Silvertown patent dielectric), bitumen, etc., all of which proved unsuccessful after a short life in the underground pipes of London.

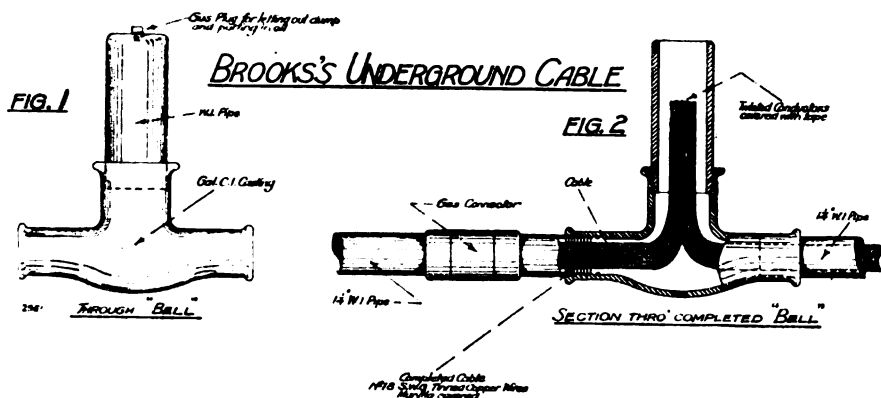
One of the earliest experiments was that of Mr. David Brooks, of Philadelphia, U.S.A., who in 1880 introduced into this country a system of insulated conductors for underground work in which kerosene was the insulating medium. At this time the Department's main telegraph circuits to the south-west part of England worked *viâ* the open route on the South-Western Railway from Waterloo and Queen's Road, Battersea, stations. It was decided to give the new system a trial by laying a line along the railway between Westminster Bridge Road and Clapham Junction with a branch to Queen's Road, and by diverting the circuits which joined the railway at those points into the experimental section.

The following brief description of the system may prove of interest. Mr. Brooks supervised the work, which was carried out by the Silvertown Gutta-Percha Company under a special agreement between the Postmaster-General and the South-Western Railway Company. I was selected to watch the interests of the Department, and to obtain particulars with a view to the future maintenance of the cable. The line consisted of thirty wires between Westminster Bridge Road and Queen's Road, and forty wires thence to the Telegraph Office, Clapham Junction. The pipe was $1\frac{1}{4}$ in-lap welded W.I. barrel, jointed with screw sockets in the usual way. The threads were, however, painted with shellac varnish in order to make a tight joint. At every 1000 ft. a special galvanised iron casting, technically termed a "bell," was fixed (1). The upper portion of the "bell" was fitted with a W.I. piece, which could be screwed on and off to give access to the joints of the wires for testing purposes.

The cable consisted of No. 18 S.W.G. tinned copper wires separately covered with manilla. They were stranded together so as to form a rope-like cable (2). The cable was coiled on drums in the usual manner in lengths of 1003 ft.

Before drawing it into the pipe the cable was carefully coiled into a large cauldron, specially made for the purpose, which was then

filled with kerosene. The cauldron generally contained about forty gallons of oil in addition to the cable. A fire was made under the cauldron and the contents raised to a temperature of about 320° F., which was maintained until every sign of moisture in the cable had disappeared. The end of the pipe was then raised from the ground and the cable drawn into it by means of a No. 8 G.I. wire put in the pipe when the latter was laid. The next length of cable was dealt with in a similar manner. The arrangements made for joining the two sections together were as follows: The end of one of the cables was passed into a "bell," which was then screwed on to the pipe. Next, the end of the other cable was passed into the "bell" and made secure to the pipe by means of an ordinary connector (2); the two ends of each conductor were then jointed together in a vertical



I AND 2.—BELL JOINTS.

position and insulated with linen tape, after which the W.I. piece was screwed in and oil poured in through the plug-hole until filled up. A small fire was then made under the "bell" to dry out any moisture that might have been absorbed by the manilla covering during jointing. The plug was then screwed in and the next section of work proceeded with.

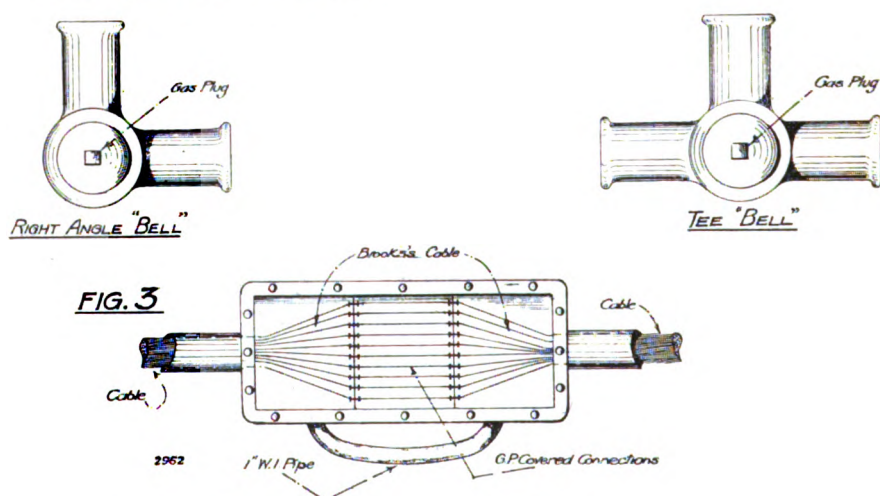
At the terminals a short length of specially prepared cable was used, one end of which was fitted with I.R. covered wires and made solid with paraffin wax so as to prevent the oil escaping. The I.R. wires were connected with the G.P. covered wires of the main underground system at Westminster Bridge Road to the railway wires at Queen's Road and Clapham Junction.

At Westminster Bridge Road, at such a height as to be above the highest point of the line, a tank was fixed which was kept filled with kerosene, the oil having previously been boiled so as to exclude any moisture it might have contained. This tank was connected

with the pipe containing the cable, in order to keep the line charged with oil to make good any leakage.

The experiment proved an expensive one for the Department ; although the pipe and fittings were made absolutely oil-tight at the time of construction the constant vibration from the railway traffic had the effect of loosening the joints and the oil leaked from the system at an alarming rate, so much so that towards the end of the trial as much as 100 gallons of oil had to be boiled and added to the system per week.

During the time it was under trial considerable time and money were spent in making efforts to patch up the leaky points, but without permanent success.



3.—ANGLE AND TEE BELL JOINTS, AND TEST BOX AT NINE ELMS.

In addition to the troubles already mentioned the wires in the cable were subject to occasional faults, the cause of which was not apparent, but was probably due to either some defect in the manufacture or to impurities in the oil. In order to afford means of localisation, and for making good defective wires by crossing-out, a specially designed test-box, 3, was inserted in the line at a point opposite Loco Junction, Nine Elms. The box was constructed with three divisions. The two end divisions were for the manilla covered cables and being part of the pipe system were kept filled with oil, while the centre division was for G.P. covered cross-connections. A diaphragm fitted with small brass terminals enabled connection between the manilla covered and the G.P. covered wires to be made. The cable was in use throughout the whole distance until the summer of 1886, when the railway company widened the line between Waterloo and Nine Elms. This work

involved the removal of the experimental cable, which was done by diverting the circuits to G.P. covered wires at Queen's Road, London and South-Western Railway, thus setting free the cable to that point.

The remaining section of the cable continued in use with more or less trouble until the end of 1889, when the circuits were diverted to a new line of G.P. covered wires to Clapham Junction, and the cable recovered.

One fault, however, occurred during the existence of the cable, which gave the writer of this article an uncomfortable thirty hours and which is perhaps worth mentioning. During some working operations one of the platelayers pierced the pipe and damaged the cable to such an extent that its removal by a standard length of 1000 feet was necessary. A new length of cable was obtained, and arrangements made with the Controller of T.S. to release the circuits, still working in the cable, on a Sunday from 8 a.m. till 8 p.m. Men were brought on duty at 5 a.m., and the work commenced; the old cable was disconnected and withdrawn, the new cable boiled and made ready for drawing in. At this juncture the man engaged in raising the pipe from the ground used too much force, with the result that it was broken at one of the sockets. Much time was lost in obtaining and fitting a new length of pipe. After this trouble was overcome the cable was drawn into the pipe and the "bells" adjusted. By this time night had come on, and ordinary naphtha lamps used for illuminating were brought into use. While preparations were being made for the jointing, the look-out man shouted, "Down Main." It should be mentioned that the work was being done in the 6-foot way between the main lines. There was a mild scamper for safety. In crossing over the pipe-line a man carrying one of the lighted lamps accidentally touched the cable with the flame and the cable end was at once in a blaze. Meanwhile, an express train came along, dashed past the flames, the driver using his whistle for all his worth. Efforts were at once directed to putting out the fire. After this had been done it was found that the ends of both cables were totally destroyed. Fortunately, the end in the cauldron at the distant point had not been cut away, and there was sufficient length to make good the damage. After this, the wires were joined up and the circuits finally restored by about 6 a.m. on the Monday.

As mentioned above, the line in places was laid in the 6-foot way between the main line so that the work on the cable was always carried out under dangerous conditions. Extreme care was of course taken by those in charge, but the responsible officer often had an anxious time with Mr. Brooks. This gentleman would insist in walking along the lines with an umbrella over his head, and the

writer recalls to mind on one occasion Mr. Brooks being pulled out of the way of the Bournemouth express. Immediately the train had passed he coolly turned round and said, "Waal, I guess that's in a hurry."
J. T. L.

THE INCOMPLETENESS OF THE PRESENT THEORY OF TELEPHONE TRANSMISSION.

By F. MURPHY, B.Sc.

THE object of this article is to demonstrate that the present theory, although sound so far as it goes, ignores one essential consideration, and by no means proves the commonly accepted law that the received speech over lines in which the attenuation is the same is equal.

The truth of the law is, however, confirmed by experience, and it is found that the transmission efficiency of any line can very approximately be judged by adding together the βl 's of the separate sections of the line, where β equals the attenuation per unit length of line and l equals the length of the respective section of line.

From what follows, and when the importance of the function ignored in the present theory is realised, the reader will no doubt agree that telephone engineers are very fortunate in finding that such a simple law as the above holds good in practice.

Let—

R = resistance of the line per unit length.

L = inductance „ „

S = leakance „ „

C = capacity „ „

p = angular velocity of the applied E.M.F.

V = voltage between the lines at any given point and time.

x = distance of given point from receiving end.

I = current in the line at any given point and time.

Then—

$$V = Ae^{px} + Be^{-px}$$

$$I = \frac{1}{Z_0} (Ae^{px} - Be^{-px})$$

where A and B are constants, Z_0 the characteristic impedance equals $\sqrt{\frac{R + jpL}{S + jpC}}$ and P^2 equals $(R + jpL)(S + jpC)$.

If the line be long and closed at the receiving end, it is generally assumed that the term e^{-px} can be neglected, whence—

$$I = \frac{A}{Z_0} e^{px}$$

hence—

$$\frac{I_0}{I_l} = e^{-Pl}$$

where I_0 = received current

I_l = sending-end current.

P may be written $P = \beta + ja$, whence—

$$\frac{I_0}{I_l} = e^{-\beta l} \times e^{-ja l}$$

Hence the ratio of the magnitude of the received current to the sent current equals $e^{-\beta l}$.

The accepted theory then goes on to deduce from this that lines in which the product βl is the same have the same received current, and hence are of the same transmission efficiency. This assumes that the current at the sending end of the line is the same in both cases, and of this no proof has been given, nor can one be, which does not take account of the nature of the action in the microphone and the induction coil.

Consideration of the sending-end impedance of a telephone line will show the nature of the assumption that the current sent into a line by a given telephone is independent of the nature of the line.

Thus let—

Z_1 = vector impedance of the receiving apparatus.

Z_2 = vector impedance of the line measured from the sending end.

Z_0 = characteristic impedance of the line.

I_l = sending-end current.

I_0 = current at receiving end.

then—

$$V = Ae^{Px} + Be^{-Px}$$

$$I = \frac{1}{Z_0} (Ae^{Px} - Be^{-Px})$$

$$x = 0 \quad \frac{V}{I} = Z_1$$

hence—

$$\frac{A+B}{A-B} = \frac{Z_1}{Z_0} \text{ or } \frac{A}{B} = \frac{Z_0 + Z_1}{-Z_0 + Z_1}$$

Again if $x = l$ = length of the line—

$$\begin{aligned} I_l &= \frac{1}{Z_0} (Ae^{Pl} - Be^{-Pl}) \\ &= \frac{A}{Z_0} \left(e^{Pl} - \frac{Z_1 - Z_0 e^{-Pl}}{Z_1 + Z_0} \right) \\ &= \frac{2A}{Z_0} \left(\frac{Z_1 \sinh Pl + Z_0 \cosh Pl}{Z_1 + Z_0} \right) \end{aligned}$$

hence—

$$A = \frac{Z_0 I_l}{2} \cdot \frac{Z_1 + Z_0}{Z_1 \sinh Pl + Z_0 \cosh Pl}$$

and—

$$B = \frac{Z_0 I_1}{2} \cdot \frac{Z_1 - Z_0}{Z_1 \sinh Pl + Z_0 \cosh Pl}$$

whence—

$$\begin{aligned} Z_2 &= Z_0 \cdot \frac{Ae^{Pl} + Be^{-Pl}}{Ae^{Pl} - Be^{-Pl}} \\ &= Z_0 \cdot \frac{(Z_1 + Z_0)e^{Pl} + (Z_1 - Z_0)e^{-Pl}}{(Z_1 + Z_0)e^{Pl} - (Z_1 - Z_0)e^{-Pl}} \\ &= Z_0 \cdot \frac{Z_0 \sinh Pl + Z_1 \cosh Pl}{Z_0 \cosh Pl + Z_1 \sinh Pl} \end{aligned}$$

If the line be very long—

$$Z_2 = Z_0.$$

Let us consider the case of a long line.

Now $Z_2 = Z_0 = \sqrt{\frac{R + jpL}{S + jpC}}$ and therefore the value of Z_0 , the sending-end impedance will vary with the natural constants of the line.

A table is given below showing the values of Z_0 for lines in common use for $p = 5000$ radians per second.

Type.		R. Ohms.	L. Milli- henries.	S. Micro- mhos.	C. Mfds.	Z_0 . Vector ohms.
Underground	10 lb. per mile . .	176	1'0	0	'071	702 43° 47'
	20 " " . .	88	"	"	'054	571 43° 22'
	40 " " . .	44	"	"	'056	398 41° 45'
	70 " " . .	25'1	"	"	'063	285 39° 22'
	100 " " . .	17'6	"	"	'058	251 37° 4'
	150 " " . .	11'7	"	"	'065	197 33° 27'
Aerial	200 " " . .	8'8	"	"	'070	170 29° 45'
	40 " BZ. per mile . .	91	4'19	1	'0075	1581 37° 45'
	70 " " " . .	52	"	"	'0079	1197 33° 18'
	100 " CU. " . .	17'6	3'90	"	'0081	805 20° 15'
	150 " " " . .	11'7	3'76	"	'0084	725 15° 16'
	200 " " " . .	8'8	3'66	"	'0086	678 12° 8'
	300 " " " . .	5'86	3'55	"	'0089	647 8° 30'
	400 " " " . .	4'4	3'44	"	'0092	621 6° 32'
	600 " " " . .	2'93	3'31	"	'0096	592 3° 19'

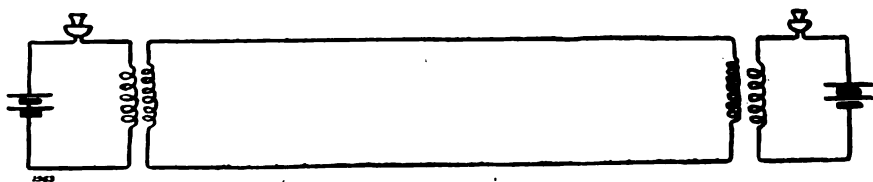
Further if the line be long, the expression for the voltage at the sending end becomes—

$$\text{sending-end voltage} = V_1 = Z_0 I_1.$$

Hence if the assumption that speaking into a telephone in a given manner produces a constant sending-end current be correct, it follows that the sending-end voltage must vary directly as the characteristic impedance of the line.

In the simplest case of two local battery telephones connected

directly together by the line, as shown in the figure, the E.M.F. producing the current in the line is equal to the sending-end voltage plus the internal voltage drop in the secondary of the induction coil of the transmitting telephone. Consequently, unless the internal voltage drop in the secondary of the induction coil be large compared to the sending-end voltage, the voltage drop on the primary of the induction coil must vary considerably with variations in the characteristic impedance of the line. This in turn would cause the voltage drop on the transmitter to vary inversely with the characteristic impedance of the line, seeing that the volts dropped on the transmitter and induction coil primary together equal a constant voltage, namely, that of the local battery. Such a state of affairs is, in the writer's opinion, difficult to reconcile with the assumption made in transmission tests that the behaviour of the transmitter is unaltered so long as the voice is kept constant, even though the line connected to the telephone is altered. For, referring to **1**, which shows a local

**FIG. 1.**

battery instrument connected through the usual induction coil to line, we have the following state of affairs. In the primary, the reactive drop and the ohmic drop due to the primary current are together equal to the voltage of the battery plus the voltage induced in the primary by the secondary current. This latter sum will remain unaltered so long as the secondary current is not changed. Therefore, a constant secondary or sending-end current implies a constant primary current. On the other hand, if the primary current does not alter, the voltage induced in the secondary by the primary current will be the same; but if the line impedance alters the sum of the sending-end voltage on a line plus the internal drop on the secondary, which is equal to the voltage induced in the secondary by the primary current, will alter. Hence the assumption that the sending-end current is independent of the nature of the line is false, and therefore it does not follow that lines of equal βl are of equal speech efficiency, even though the lines are of great electrical length.

Mr. Aldridge, in his paper on "Telephone Transmission Calculations" before the Institute of Electrical Engineers on May 30th, 1913, has stated that a C.B. telephone produces an approximately constant voltage on the line side of the repeater, whatever the character of the line to which it is connected. The writer hopes to

publish, later, details of some experiments showing that in the Post Office L.B. telephone circuit the voltage supplied by the secondary of the induction coil is also approximately constant and independent of the nature of the line to which the telephone is connected. Constant sending-end voltage would imply that terminal effects would be observed with the use of different types of lines, as the following will show:

For—

$$V_l = Ae^{Pl} + Be^{-Pl}$$

$$I_0 = \frac{1}{Z_0} (A - B)$$

hence—

$$\begin{aligned} \frac{I_0}{V_l} &= \frac{1}{Z_0} \frac{A - B}{Ae^{Pl} + Be^{-Pl}} \\ &= \frac{1}{Z_0} \frac{2Z_0}{(Z_1 + Z_0)e^{Pl} + (Z_1 - Z_0)e^{-Pl}} \end{aligned}$$

hence—

$$I_0 = \frac{2V_l e}{(Z_1 + Z_0)e^{Pl} + (Z_1 - Z_0)e^{-Pl}}$$

This formula contains not only Z_1 , the impedance of the receiving telephone, but also Z_0 , the characteristic impedance. Thus the received current I_0 will vary according to the value given to Z_0 . In the case of long lines, the expression reduces to

$$I_0 = \frac{2V_l}{(Z_1 + Z_0)l^{Pl}}$$

If, therefore, a number of lines are compared with the same pair of telephones the received current will vary as $\frac{1}{Z_1 + Z_0}$, and such variation, from the value obtained by assuming that Z_0 has the value appropriate to standard cable, is known as terminal loss or gain.

This terminal effect varies from about 1 m.s.c. gain to $4\frac{1}{2}$ m.s.c. loss when comparing long lines. In practice, however, these gains and losses are not found, and the writer considers that this is due to the fact that subscribers' lines are never directly connected to a great electrical length of line whose characteristic impedance is materially different from that of standard cable. In large towns, on a C.B. exchange, a subscriber is usually served through 10 lb. or 20 lb. ug., and in either case no terminal effect would be detected. There are, however, a number of subscribers served by means of 40 lb. bronze wire, and in this case the characteristic impedance is considerably different from that of standard cable. The electrical length of the 40 lb. bronze used is, however, usually small, not more than 3.5 m.s.c., before the circuit becomes 100 lb. or 150 lb.

copper, and in such cases the sending-end impedance approximates to the impedance of the receiving circuits, namely, 100 lb. or 150 lb. copper. The terminal effect in such a case might be of the order of 2 m.s.c. loss, but it would be impossible to separate such a loss from the loss which occurs when an aerial line becomes noisy, or that due to the apparatus not being in perfect order.

In conclusion, it would appear that the rule that lines of equal βl are equal for speech efficiency can be safely used in practice, because the terminal effect with different types of lines of great electrical length is small, and is even smaller in practice, due to the fact that lines whose characteristic impedance is widely different from that of standard cable do not occur in great electrical lengths in this country.

(To be continued.)

DEVELOPMENTS IN THE STROWGER AUTOMATIC SYSTEM.

By J. HEDLEY,
Engineer-in-Chief's Office.

A DESCRIPTION of the Strowger Automatic System in use at Epsom and the Official Switch exchanges was contributed by Mr. W. J. Bailey in the July, 1912, issue of this JOURNAL, vol. v, part 2. Since that date several improvements have been introduced in collaboration with the engineers of the Automatic Telephone Manufacturing Company, in connection with the installation of new automatic exchange equipments at Accrington, Newport, Chepstow, Paisley, Portsmouth, Leeds, and Blackburn, and a brief outline of the progress made may be of interest to our readers.

The circuit arrangements and equipment in general provided for the trial exchanges at Epsom and Official Switch followed standard American practice, and although suitable for a self-contained local system it was soon apparent that the traffic facilities and engineering arrangements did not fully accord with British Post Office manual practice, and the aim of the developments made has been to improve the system in these respects as far as possible, and also to provide circuits suitable for linking up the automatic with an extensive trunk and local junction service.

IMPROVED TRAFFIC FACILITIES.

(a) Facilities provided on line switch units for cross-connecting subscribers lines to any line switch, thus affording means for dis-

tributing the originating traffic equally on the line switch units. This arrangement also enables the spare numbers to be allotted in sequence, instead of allotting the numbers to suit the load on each unit. The conditions therefore compare with those available on standard C.B. manual exchanges.

(b) Transmission of the busy flash signal to the originating "A" operator on the manual board when the called subscriber is engaged, instead of applying the busy tone only.

(c) Immediate trip of the ringing current when the called subscriber lifts his receiver, thus preventing the noise due to the generator alternations.

(d) Facilities for readily increasing the number of routes incoming to connectors on any unit without altering any of the permanent wiring. The connectors can be increased one by one up to a maximum of 19 on P.B.X. units and 16 on other units.

(e) Meter of originating subscriber operated on auto. to auto. calls only, instead of operating on calls for (1) dead number circuits and (2) faulty circuits connected to plugging-up lines. This scheme obviates asking the originating subscriber for his number and then making out a credit ticket.

(f) Facilities for working 2-party line circuits automatically.

(g) Facilities for working coin box circuits automatically, the circuit arrangements being such that the coin box subscriber can speak to the manual board operator without inserting the coin. These calls reach the operator on circuits fitted with red lamp caps — to indicate that a coin box subscriber is calling, and the operator is provided with the usual buzz when the coin is inserted, on demand, for successful calls.

This scheme also obviates asking for the subscriber's number and making out a credit ticket for unsuccessful calls.

(h) Manual board calls to and from automatic subscribers fed direct from the manual board cord circuit, thus improving transmission and placing the release of the call entirely under the operator's control. Standard C.B. supervision is afforded to the operator.

(i) Facilities afforded for dialling automatic subscribers direct from sub-exchanges, standard supervision being afforded at C.B. and C.B.S. exchanges, and back release of the called subscriber at magneto exchanges.

(j) Provision of secondary line switches between primary line switches and 1st selectors to enable the originated traffic from each group of 100 subscribers to be spread over a larger group of selectors, *i. e.* the outlet from each group is not limited to its own ten selectors. Each of the trunks outgoing from the primary line switches are distributed among different groups of secondary line switches, each of the latter having access to ten 1st selectors. This scheme dis-

tributes the traffic more uniformly over the entire exchange, and so affords better traffic conditions. The arrangement is in use in America, but has not been previously used by the British Post Office.

(*k*) Key-ended order wire incoming junctions, directly associated with selectors, instead of plug-ended order wire junctions. This scheme has been developed with the object of increasing the traffic capacity of the "B" position.

There are several other improvements, which cannot be definitely stated to afford additional or improved traffic facilities, but which do advantageously affect the service rendered the subscriber; these will be covered under:

ENGINEERING IMPROVEMENTS.

(*l*) One wire meter circuit. This scheme is cheaper from a cabling point of view, and as metering relays are operated by the reversal of current instead of the meter when the calling subscriber replies, a better margin of adjustment is available and consequently less danger of faulty registration of the meter. The latter is now operated on the local circuit of the metering relay.

(*m*) The group ringing relays and ringing vibrator have been replaced by a standard ringing machine; an additional slip-ring provides for the necessary distribution of the ringing, and the maintenance conditions are thus improved.

(*n*) The fibre terminal assemblies, on line switch units and selector boards, have been replaced by standard terminal strips on line switch units, and a special tag board on the selector boards. The new scheme is more robust and provides for alterations being made without altering the permanent wiring.

(*o*) A "numbering scheme" has been provided, whereby each switch and the outgoing and incoming routes are designated in such a manner that the tracing of calls, backwards or forwards, can be effected with the minimum of difficulty.

(*p*) An emergency alarm scheme has been developed, whereby the alarm circuits are extended to the manual board during the night and on Sundays. The alarms are associated only with those circuits which actually affect the working of the exchange, such as auto. and manual fuses, failure of ringing, etc. An emergency bell is provided, and the operating staff are instructed to send for the officer allotted for emergency duties.

(*q*) Arrangements provided for ready removal of the master switch, without displacing the line switches.

(*r*) Subscribers' meters removed from the top of the line switch units and mounted on meter racks, in such a position that the meters are readable from the manual exchange switchroom.

AUTOMATIC THE STROWGER AUTOMATIC SYSTEM.

- (s) Improved line switch circuit.
- (t) Improved master switch circuit.
- (u) Improved connector circuit.
- (v) Improved supervisory alarm circuit.
- (w) Improved test connector circuit arrangements.
- (x) Improved manual board cord circuit.

It will be convenient at this stage to deal with the circuit operation of the various circuits affected in order to appreciate the manner in which the developments have been made.

PRIMARY LINE SWITCH CIRCUIT (I). (See page 168.)

- (1) Subscriber lifts receiver and loops the lines.
- (2) Line relay 500^w operated.
- (3) " Pull down " coil 45^w of line switch energised.
- (4) Line switch plunges into back contacts, causing:
 - (a) —, +, and release trunks to be extended to secondary line switch bank.
 - (b) Meter to be associated with metering relay circuit.
- (5) Metering relay 2000^w operates *via* subscriber's meter, the latter is not energised.
- (6) Bridge cut-off coil of line switch, 1200^w, operates *via* release trunk, retaining the plunger in position with a small current.

It will be seen that this line switch circuit resembles very closely the line and cut-off relay arrangement in standard C.B. manual exchanges; its operation is much simpler and more reliable than that installed at the original installations at Epsom and Official Switch exchanges, and indicates one of the developments introduced by the Automatic Telephone Manufacturing Company.

PRIMARY MASTER SWITCH CIRCUIT (I).

- (1) Starting relay, 1300^w, operates *via* earth on metering relay, 2000^w.
- (2) Locking relay, 70^w, operates *via* 5^w coil of supervisory relay causing: (a) Pin to be withdrawn from master switch quadrant; (b) open main battery disconnected from line switch.
- (3) When no earth on the bank contact, locking relay de-energised, pin returns and battery reconnected. This occurs each time a trunk is taken up.
- (4) When master switch wiper reaches No. 1 contact, the trip relay circuit is prepared by finger No. 1, and when No. 1 is taken:
 - (a) Starting relay operates.
 - (b) Locking relay operates.
 - (c) Tripping relay operates, and solenoid energised and all relays

retain until the wiper is pulled back to No. 10. The trip relay circuit is now released by finger No. 10, and the wiper is pulled forward to the first disengaged trunk.

(5) During the return journey of the master switch, all line switch plungers not associated with the master switch shaft are lined up.

The improvements introduced are as follows :

(a) Slow release relay, 1100^W, energised when locking relay, 70^W, operated to delay the operation of any line switch until disengaged trunk associated, thus reducing possibility of double connections to a minimum.

(b) 1300^W coil of starting relay, not associated with bank contact positively, retains the circuit as soon as the trip relay is energised.

(c) The 1000^W winding of the supervisory relay operates should the pin mount on the teeth of the quadrant, as the locking relay springs are then operated mechanically. This provides an alarm against unsatisfactory working of the master switch.

SECONDARY LINE SWITCH CIRCUIT (1).

(1) When earth placed on metering relay, 2000^W, secondary line switch circuit is completed from battery, 2-3^W winding of tell-tale relay, contacts of stop relay 1300^W, contacts of locking relay 70^W, 18^W + 2775^W relay in series, contacts of relay 2300^W, 10^W relay, springs of secondary line switch relay, 85^W winding of latter to earth *via* contacts of 2000^W metering relay.

(2) Relay 18^W + 2775^W operates, short-circuits its high resistance winding, then the 10^W relay operates and the secondary line switch plunges in.

(3) First selector line relay, 250^W + 250^W, operates *via* subscriber's loop, thus placing earth on the release trunk.

(4) Operation 2 completes circuit of primary line switch bridge cut-off relay 1200^W, and 1300^W coil of double wound metering relay. This latter relay is not operated as current in line winding from first selector is in opposition.

(5) Operation 2 also disconnects relay 10^W, battery now flows *via* 1168^W and 85^W windings of secondary line switch relay to earth *via* 2000^W metering relay.

(6) The 10^W relay releases slowly, and thus maintains the connection of the bridge cut-off relay until the earth is provided on the first selector release relay 1300^W.

(7) Operation 2 also completes circuit of 1300^W, secondary master switch start relay *via* master switch bank contact. The secondary master switch circuit then operates similarly to the primary master switch.

When all the ten first selectors, outgoing from a group of secondary line switches are engaged, it is necessary that all the idle primary line switches associated with the particular group of secondary line switches should be at once connected to another group having idle first selectors.

(1) It will be noticed that the 2300^w in the secondary master switch circuit is normally operated, *viâ* the start relay 1300^w, consequently when the latter relay remains operated, which will be the case if the master switch hunts, or continuously finds earth on the secondary line switch bank, the slow release relay 2300^w is de-energised.

(2) All the primary master switches associated with this group of secondary line switches will now be operated from battery *viâ* 1300^w winding of start relay, primary master switch bank, 85^w winding and contacts of secondary line switch relay, 10^w relay, contacts of 2300^w relay to earth, and will thus be moved on to an idle group of secondary line switches. The secondary line switch relays are not operated under this condition.

(3) As each one of the ten first selectors are engaged, the associated chain relay 3300^w is operated, and when the ten chain relays are energised simultaneously, the circuit of the 1300^w stop relay is completed.

(4) Operation 3 disconnects battery from the secondary line switches and secondary master switch, and also operates rotary switch relay 500^w, which locks and completes the circuit of the rotary magnet and 5^w relay.

(5) The 1300^w relay is now energised, and breaks the circuit of the 5^w relay and rotary magnet; this operation is repeated and the rotary magnet thus moves the wipers over the bank contacts of the rotary switch.

(6) Operation 5 places earth on each of the rotary switch bank contacts and completes the circuit of the 1300^w start relays of the primary master switches having access to this group of secondary line switches.

(7) The operation of the starting relays, 1300^w, enables each primary master switch to rotate completely—the 1300^w relay of the rotary switch is “slow release” for that purpose—thus ensuring that all idle line switches are picked up. This is essential as some of the line switches may not be lined up with the master switch and may be standing opposite the group of secondary line switches, with all the ten selectors engaged.

(8) When the rotary switch reaches the last contact, relay 250^w is energised and the release magnet operates, thus restoring all relays.

(9) One rotary switch is provided for ten secondary groups; thus

if the engaged condition still exists on any of the ten groups, the rotary switch will again line up the line switches of the group concerned.

(10) The function of the 2775^w coil of the 18^w + 2775^w relay is to enable the primary switch starting relay, 1300^w, which acts in parallel with this relay, to operate with precision.

(11) The 1330^w coil of the tell-tale relay operates in series with its 2·3^w coil when the locking relay is energised, to save battery consumption.

FIRST AND SECOND SELECTORS.

The circuit operation is precisely similar to the Epsom and Official Switch exchanges. Associated with the first selector line relay is an alarm lamp (white) for the purpose of bringing under notice "P.G." faults, or failure to dial, etc.

CONNECTOR (I).

The connector circuit has been redesigned to embody some of the new features previously referred to, and the functions are briefly as follows:

(a) Actuate the apparatus in response to the last two digits (tens and units) dialled in order to find the called subscriber's line.

(b) Intermittently ring the subscriber if disengaged.

(c) Operate the originating subscriber's meter on completed calls only.

(d) Supply talking current to both subscribers.

(e) Control the engaged condition of each subscriber's line and all other circuits concerned in the connection.

(f) Release all apparatus in use as soon as the originating subscriber restores his receiver.

(g) Give a back release alarm if the latter fails to restore after the called subscriber has restored his telephone.

(h) Transmit busy back signal if called subscriber engaged.

(i) Switch the relay bridges out of circuit on calls completed from the manual board.

It will be evident from item (i) that some discriminating relay is necessary in order to differentiate between such calls and conversations between two automatic subscribers. This discrimination is effected by means of the 1300^w and 25^w relay associated with the release trunk. For auto. to auto. calls, battery, *via* the bridge cut-off coil of the primary line switch, is extended to the release trunk and current passes *via* the 25^w coil of the 1300^w and 25^w relay to earth on the release relay 1300^w. Relay, 1300^w and 25^w, operates and

locks *via* its 1300^w winding and short-circuits its 25^w winding. The operation of this relay disconnects the circuit of the switching connector relay 1300^w. Hence auto. to auto. calls pass through in the normal way, and the relay bridges for supplying talking current are not cut out of circuit.

For calls from the manual board, earth is extended to release trunk; consequently the 25^w winding of the 1300^w and 25^w relay is short-circuited by the earth on the connector release relay 1300^w, and consequently the circuit of the switching connector relay 1300^w is not disconnected, but is free to operate on a successful call, as will be described later.

(1) When the connector is first associated with the selector, relay *A* operates, then relay *B* is energised.

(2) Relay *A* responds to impulses from dial and vertical magnet operated correspondingly, *via* relay *D*, contacts of *B* and *A*, and wipers lifted to the tens' level required. Relay *D* and private 175^w operated, and springs *K* also close with vertical movement of shaft.

(3) When tens' digit completed relays *D* and private de-energise, the release of the latter mechanically shifts side switches 1 and 2 to the second contact.

(4) Relay *A* again responds to impulses from dial, and rotary magnet now operates correspondingly, etc., as in 2, and wiper reaches the called subscriber's line.

(5) If line engaged, private relay 175^w is retained *via* normal contacts of relay *D* (now de-energised) relay *F*, side switch No. 1, position 2, *via* private wiper to earth on engaged subscriber's release relay.

(6) Busy relay *F* and private relay remain energised *via* springs *K*.

(7) Rotary magnet disconnected so that subscriber cannot again rotate wiper. Private wiper clear.

(8) Busy-back tone transmitted to originated subscriber, from earthed secondary winding of transformer, ringing machine interrupter, contacts of busy relay *F*.

(9) If call from manual board, the 48^w *via* 120^w and interrupter, flashes the supervisory relay on the cord circuit.

(10) If called subscriber's line is free, private relay 175^w releases and side switches 1 and 2 pass to position 3, earthing private and operating the bridge cut-off coil of called subscriber.

(11) Relay *H* 1300^w energised from battery, side switch No. 2, contacts switching relay *Y*, to earth on side switch No. 1; called subscriber rung *via* contacts of ringing trip relay *E* 1300^w and 200^w.

(12) When the called subscriber replies, the ringing trip relay is at once operated from battery *via* side switch No. 2, its 200^w coil and contacts, contacts of relay *H*, subscriber's loop to earthed generator.

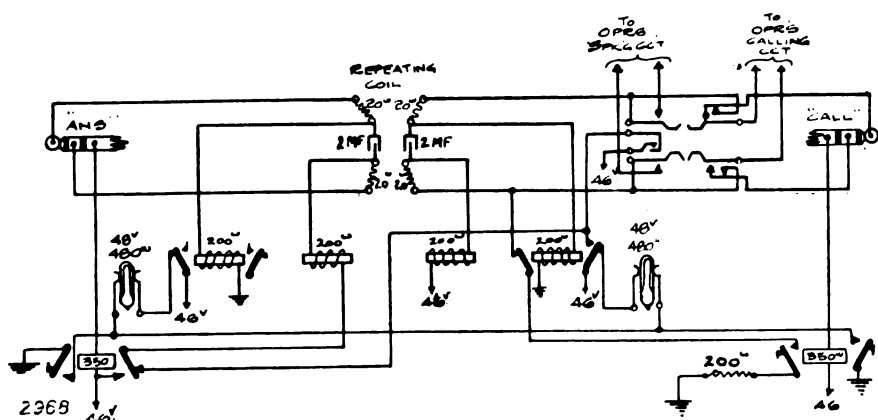
Trip relay *E* locks, *via* its 1300^w coil and springs *K* to earth, and ringing disconnected.

(13) For auto. to auto. calls back-bridge relay *C* is energised *via* subscriber's loop, thus reversing the current towards the originating subscriber and operating his meter.

(14) For manual board calls, battery *via* side switch No. 2, connector switching relay Y 1300^w, contacts of discriminating relay G, contacts of trip relay E, to earth on private *via* manual board.

(15) Connector switching relay operates, disconnecting relay *H*, and the called subscriber's line is fed direct from the operator's cord circuit, thus affording the maximum efficiency from a transmission standpoint.

(16) The release of the connection is now entirely under the



2.—MANUAL BOARD UNIVERSAL CORD CIRCUIT.

operator's control. For auto. to auto. calls the usual release conditions are unaltered.

(17) If the called subscriber restores before the originating subscriber, the back-release alarm lamp (white) glows, *via* back bridge relay *C*, relays *H* and *E* and springs *K*. It will be noticed that the introduction of the switching connector relay has enabled the number of side switches to be reduced from 4 to 2.

MANUAL BOARD CORD CIRCUIT.

At Accrington, Newport, Portsmouth, and Paisley this circuit is of the No. 12 "Stone" type, similar to that described in this JOURNAL in the July, 1914, issue for the Darlington Automatic Exchange, with 24 volt feeding battery.

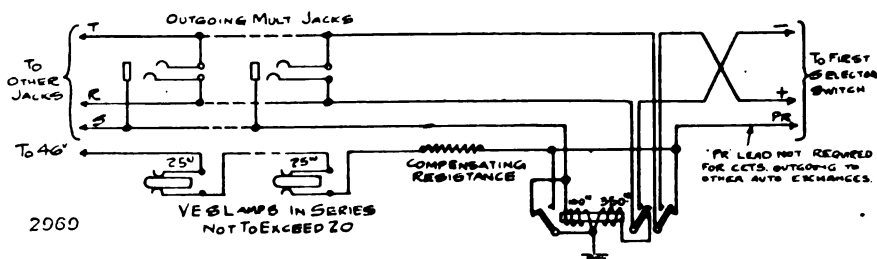
At Blackburn a 48 volt repeating coil cord circuit will be employed as indicated in 2. This circuit is an improvement for use on long trunk lines, as it is not so liable to induction due to slight leaks or

AUTOMATIC THE STROWGER AUTOMATIC SYSTEM.

out-of-balance conditions. The 200^{ohm} earth connection on the calling sleeve relay is for the purpose of maintaining the circuit of the connector line relay after dialling is completed. In other respects the operation of the circuit follows standard practice.

MANUAL BOARD JUNCTION OUTGOING TO AUTOMATIC (3).

These circuits are multiplied on all operators' positions, and provided with visual engaged lamp signals. They are directly associated with first selectors, and are used for completing all calls from the manual board for automatic subscribers. When the plug is inserted into an idle junction, the 350^{ohm} coil of the sleeve relay is energised from the ring of the calling plug. This enables the 30^{ohm} coil to be operated from the sleeve of the plug. This circuit arrangement is essential, in order to ensure that false impulses shall not



3.—MANUAL BOARD JUNCTION OUTGOING TO AUTOMATIC.

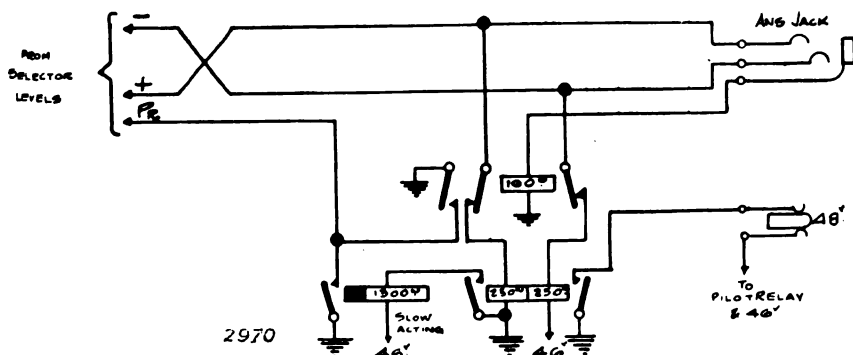
reach the selector line relay during the insertion of the plug. It will be evident that as one 250^{ohm} coil of the selector line relay is connected to battery and normally associated with the *B* line, it is necessary to keep this line disconnected until the plug is fully inserted, otherwise the earth on the tip of the calling plug in riding over the ring spring of the jack will give an initial false impulse, which will result in a wrong connection being set up. The earth placed on the private, when the sleeve relay is operated, is for the purpose of operating the connector switching relay, in order that the called subscriber shall receive current direct from the operator's cord circuit, as already explained under "connector." The battery (*via* the visual engaged lamps) is connected to the back contact of the sleeve relay for the purpose of operating the 350^{ohm} coil, if the dialling key is thrown before the calling plug is inserted.

JUNCTION INCOMING FROM AUTOMATIC SELECTORS TO MANUAL BOARD (4).

When a subscriber desires to make a trunk call, or inquiry call, he is requested to dial "0" and "9" respectively. These selector

THE STROWGER AUTOMATIC SYSTEM. **AUTOMATIC**

levels are joined to the manual board as shown. Immediately an idle line is found the 250^w + 250^w relay is energised round the subscriber's loop, the calling lamp glows, and the 1300^w slow releasing relay is operated to place earth on the private of the selector bank multiple to guard against interference. When the operator answers the 100^w cut-off relay is operated, thus disconnecting the calling relay and lamp, earthing the private, and placing the release of the connection under the entire control of the manual board operator. The standard supervision is afforded the operator as the subscriber is directly connected with the 48 volt cord circuit on the manual board, thereby securing the maximum efficiency from a transmission standpoint.



4.—MANUAL BOARD JUNCTION INCOMING FROM AUTOMATIC. ALSO DEAD LEVEL CIRCUIT.

DEAD LEVEL CIRCUIT (4).

When a subscriber dials a thousand's digit which is not allotted for the automatic subscribers' numbers, or for miscellaneous services to the manual board, his line is at once connected with a spare dead level circuit. These circuits were at first designed to terminate on keys and lamps, but a jack-ended scheme is considered to have traffic advantages, inasmuch as team working is available, and this method has been adopted as standard. The circuit arrangements are identical with (4).

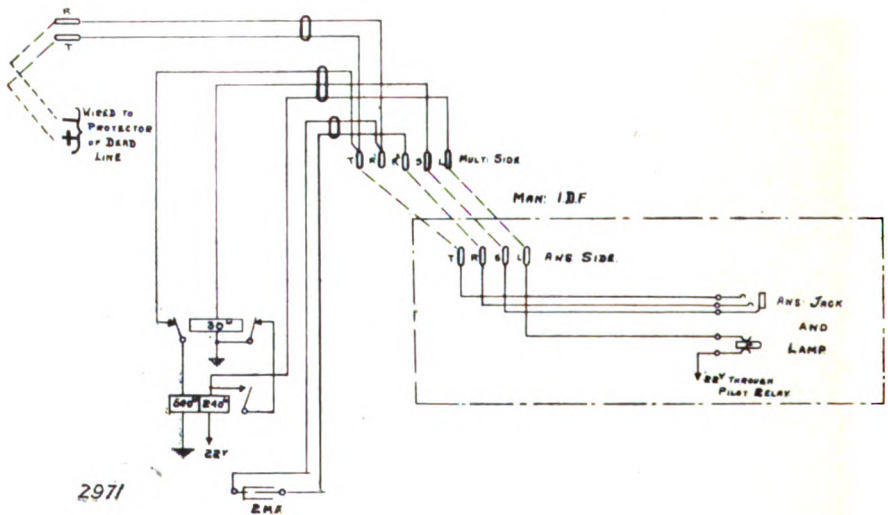
DEAD NUMBER CIRCUIT (5).

Ceased subscribers' numbers, and numbers unallotted to subscribers, are associated with this equipment, so that subscribers calling these numbers may be notified by the enquiry operator. These circuits were at first designed to terminate on keys and lamps,

but a jack-ended scheme is considered to have traffic advantages as team working is available.

When two or more subscribers' numbers are associated with one dead number equipment, the "privates" of each subscriber's line is commoned on the line switch unit I.D.F., so that only one calling subscriber at a time can obtain connection with the enquiry operator. A second caller for any of the dead numbers will receive the busy-back signal. The circuit operation is as follows :

- (1) Ringing current from connector operates relay $500^w + 240^w$, which locks, *via* 240^w coil, and calling lamp glows.
- (2) Ringing trip relay of connector is operated *via* 500^w winding



5.—DEAD NUMBER CIRCUIT.

to earth, thus switching the dead number equipment through to the originating subscriber.

(3) Operator inserts answering plug, but presence of 2-mf. condenser on line prevents the back-bridge relay in the connector circuit from operating. The call is, therefore, not registered on the calling subscriber's meter.

(4) Operation of 30^w sleeve relay de-energises relay 500^w + 240^w, and extinguishes calling lamp. Operator furnishes information required by subscriber.

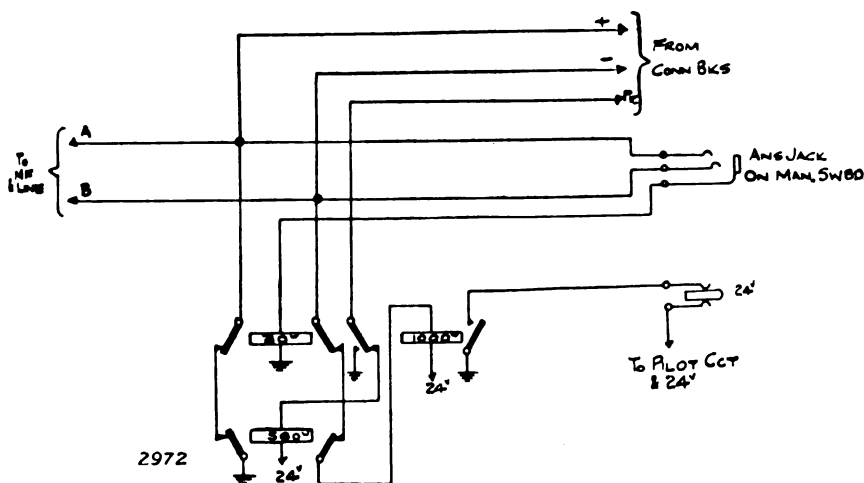
COIN BOX SUBSCRIBERS WORKED AUTOMATICALLY.

Any automatic telephone number may be allotted to these subscribers, but in order that their trunk and junction calls may reach the manual board operator on circuits fitted with red lamp caps—as

an indication that a request for the coin to be deposited should be made—these circuits are cross connected to units set aside for the purpose, *i. e.*, the levels allotted for manual board calls are separated from the ordinary subscribers. This scheme is applied at Newport, Portsmouth, Leeds, Chepstow, and Blackburn.

COIN BOX SUBSCRIBERS CONNECTED TO MANUAL BOARD FOR
ORIGINATING TRAFFIC (6).

These subscribers are allotted numbers on the automatic exchange, and the circuit arrangements are such that they are obtained automatically by all other subscribers, and calls originated by the coin



6.—COIN BOX SUBSCRIBERS CONNECTED TO MANUAL BOARD, AND OBTAINED AUTOMATICALLY BY OTHER SUBSCRIBERS.

box subscribers reach the manual board operator. The calling lamps are fitted with red lamp caps and the procedure on ordinary C.B. manual exchanges is followed as regards the collection of the coin. When the coin box subscriber lifts his receiver, the 1000^w relay is energised and the calling lamp glows. When the operator answers, the 30^w cut-off relay is operated, the lamp circuit is disconnected and earth is placed on the private to guard the circuit on the connector banks against calls incoming from other subscribers, thus giving the usual busy condition. The operator is afforded the standard C.B. supervision. For calls incoming to the coin box subscribers, the line is directly connected to the connector, and when earth is placed on the private at the connector the 500^w relay is energised, thus disconnecting the earth on the tip, and 1000^w to battery on the ring, and isolating the calling lamp circuit. This scheme is applied at Accrington and Paisley.

AUTOMATIC THE STROWGER AUTOMATIC SYSTEM.

2-PARTY LINE CIRCUITS WORKED AUTOMATICALLY.

(1) Flat rate subscribers are provided with ordinary automatic wall or table telephones only; for limited rate subscribers automatic coin boxes, or call meters (described by Mr. Watkins in the April, 1915, issue of this JOURNAL), are also fitted at the subscribers' stations according to the tariff of the subscribers.

(2) The bell of the X subscriber is connected to earth on the A line, and the bell of Y subscriber on the B line in the usual manner.

(3) The reversal of the cross connecting wires in the exchanges, in order to ensure that the ringing current traverses the right line for each subscriber, cannot be followed, as will be explained later. The ringing leads on the connector trip ringing relay on the Y units are reversed so that the correct ringing is applied.

(4) Each party line subscriber is allotted a separate telephone number, the Y subscribers in a different unit from the X subscribers.

(5) The "private" leads of the two subscribers are jumpered on the line switch unit I.D.F., to provide engaged facilities should either subscriber call or be called.

(6) The line switch on the X unit only is jumpered, so that all originated traffic will be dealt with on one exchange equipment, and be metered on that unit only. The spare Y line switch unit is available for "dialling in" junction circuits from sub-exchanges.

(7) Calls for the manual board are routed *via* separate junctions incoming to the manual operator similarly to an automatic coin box subscriber. The circuits are fitted with red lamp caps to indicate to the operator that a request should be made for the coin to be deposited when the call is successful.

(8) Item 6 permits party line subscribers fitted with coin boxes to reach the manual board operator without depositing the coin. It is this condition that prevents the reversal of the cross-connection of the Y subscriber on the main frame, because when the operator answers the polarised relay in the coin box would be inoperative for the X subscriber and operative for the Y subscriber.

(9) Calls between X and Y subscribers on the same line are dealt with similarly to junction calls, *via* the manual board, *i.e.*, the originating subscriber is instructed to dial "o." The operator will accept the call, withdraw the answering plug, insert the calling plug and ring the subscriber by means of the ringing reversing key on her position. The calling plug is left in the jack during the progress of the call and the usual supervision afforded.

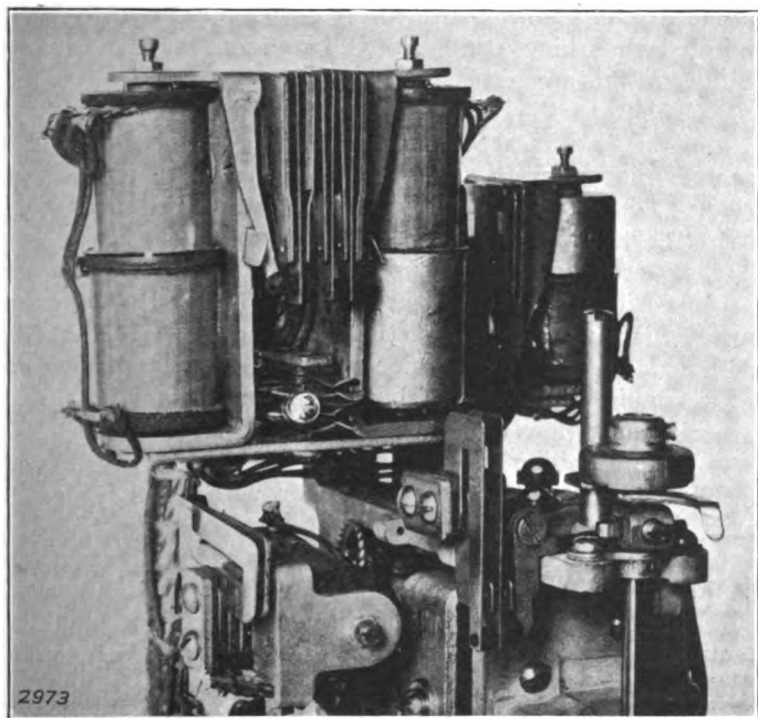
ADDITIONAL SUPERVISORY ALARMS.

(a) Line switch and master switch alarms improved. The blue

alarm lamp circuit, provided to indicate master switch and line switch faults, has been improved as follows :

Five subsidiary lamps have been provided, one (red) for indicating master switch quadrant faults, and four (white) for line switch faults, and lamp for each twenty-five switches, thus enabling faults to be located more rapidly.

(b) P.G. alarm lamp associated with first selector line relay to bring under notice cases where originating subscribers engage



7.—PORTION OF FIRST SELECTOR SHOWING P.G. ALARM LAMP.

selectors by removing the receiver, but fail to dial, or cases of line faults. 7 shows a portion of a first selector, with the P.G. lamp mounted between the two relays at the top.

(c) *Ring Failure Alarm*.—In the event of a failure in the ringing machine circuit, the circuit of a slow release relay normally energised by the ringing current is broken, and the alarm bell circuit is completed. A tumbler switch is provided in the relay circuit to check the alarm bell daily.

(d) *Retarded Alarms*.—A scheme is being installed to retard for a period of three minutes the alarms for back release and P.G.s on

first selectors, which generally occur for a shorter period, and disappear before attention can be given.

KEY-ENDED INCOMING ORDER WIRE JUNCTION CIRCUITS (8).

This scheme is applied at Paisley on the Glasgow-Paisley trunk circuits.

Associated with each circuit are three buttons of the order wire type, labelled "Speak," "Release," and "Calling Device"; three lamps, labelled "Junction," "Engaged," and "Subscriber"; and one strip of ten keyboard calling device buttons, associated with two impulse machines common to all junctions on the position. The functions of this apparatus are:

- (1) The "speak" key is provided to enable the "B" operator to listen-in, and, in case of difficulty when the auto. subscriber repeatedly flashes in, to speak, but it is considered this key will be little needed, as the supervisory signal is transmitted to the originating "A" operator.
- (2) The release key is depressed to break down the connection with the called automatic subscriber. The "B" operator will depress this key on the completion of all connections, *i. e.*, when all the three lamps glow simultaneously, or in the case of slow clearing by the originating "A" operator, when the "engaged" and "subscriber" lamps glow.
- (3) The "calling device" key is depressed to associate the junction allotted by the "B" operator with the keyboard calling device.
- (4) The "junction" white lamp glows under the two following conditions:
 - (a) Immediately the originating "A" operator plugs into the junction allotted, before the "calling device" key is depressed by the "B" operator.
 - (b) Immediately the originating "A" operator withdraws the plug from the junction, before the "release" key is depressed by the "B" operator.
- (5) The "engaged" green lamp glows to indicate to the "B" operator that the junction concerned cannot be allotted. It will therefore glow until the "A" operator's plug is withdrawn and the "B" operator's release button depressed to restore her equipment to normal.
- (6) The "subscriber's" red lamp is the equivalent of the called subscriber's supervisory lamp, and is provided to enable the "B" operator to release the automatic connection should this lamp continue glowing, and the junction lamp remain dark, *i. e.*, if the "A" operator is slow in clearing the connection. Such conditions do happen on through calls, when the control is vested in an exchange



8.—KEY-ENDED INCOMING ORDER WIRE JUNCTION CIRCUIT SHOWING WIRING OF KEYBOARD CALLING DEVICE.

AUTOMATIC THE STROWGER AUTOMATIC SYSTEM.

of the magneto type, or one where the clear from the originating subscriber is not received.

(7) The keyboard calling device is provided with ten digit buttons, one starting button, one cancel button, and one keyboard engaged lamp. Associated with the keyboard are two electro-mechanical calling device machines, and adjacent to the keyboard are fitted two lamps which glow to indicate which calling device machine is in use. The calling device machines are automatically associated with the keyboard buttons, and the lamps merely indicate which set is in use, *i. e.*, one of these lamps will glow to indicate that the corresponding electro-mechanical calling device is transmitting to the automatic selectors the impulses sent in during the period that the operator is setting up on the keyboard a second call *viâ* the other calling device. The engaged keyboard lamp glows until the number is completely set up by the operator, *e. g.*, an operator may set up the subscriber's number and fail to depress the "start" button. Under this condition the engaged keyboard lamp will glow to indicate that the calling device machine is "charged." The lamp is thus a guard against setting-up another call incorrectly. The depression of the start button extinguishes the keyboard engaged lamp, delivers the impulses to the first selector for the number set up, and switches the keyboard buttons to the idle calling device ready for another call. The cancel button may be used to cancel numbers incorrectly set up, before the start button is depressed.

The circuit operation is as follows :

- (1) "A" operator plugs into the junction allotted.
- (2) Relay 12,000" + 27" operates ; relay 1000" is then energised and "junction," and "engaged" lamps glow.
- (3) "B" operator depresses "calling device" key associated with the junction allotted, operating and locking the two relays 1000" in parallel *viâ* earth on the release key.
- (4) Operation 3 places earth on the private lead of the selector, completes the circuit of the subscriber's supervisory lamp, maintains the circuit of the engaged lamp, and disconnects the "junction" lamp.
- (5) Operation 3 also completes the circuit of No. 1 connecting relay 500", *viâ* the back contact of switching relay 500". It will be evident from the circuit diagram that when this latter relay operates No. 2 connecting relay 500" will be operated instead of No. 1. This point will be referred to later.
- (6) Connecting relay 500" locks *viâ* release key, contacts of holding group relay 1000", and winding of slow-release relay 500". The latter relay is also energised, thus completing the following circuits:
 - (a) Calling device impulse springs associated with the first selector.

(b) Calling device lamp glows.

(c) Relays locked, *viâ* contact of 500^W release relay.

(7) "B" operator depresses the keyboard digit buttons corresponding to the subscriber's number. Keyboard engaged red lamp glows. Digit relay is energised, *viâ* contact springs between sixth and seventh button, and the digit solenoids corresponding to the buttons depressed are operated. The impulses are stored on the calling device by means of a mechanical contrivance until the start button is depressed.

(8) The keyboard buttons are now switched to calling device machine No. 2, ready for another call, as follows:

(9) 48^v *viâ* switching group relay 1000^W, contacts of 500^W relay, start button, contacts of 500^W relay to earth. 1000^W relay operates, and locks, *viâ* the two 500^W relays in series, both of which also operate to switch in calling device machine No. 2.

(10) Depression of "start" button also operates start relay, and latter completes circuit of holding group relay 1000^W. The former closes the motor circuit of the calling device machine, and the stored impulses are transmitted to the first selector. The latter completes the circuit of the position meter circuit, and short-circuits slow-release relay 500^W.

(11) When the calling device machine is cleared, start relay de-energises, thus disconnecting holding group relay 1000^W, which in turn extinguishes calling device lamp and releases connecting relay 500^W. The latter now associates the junction with the called subscriber's line.

(12) The subscriber's supervisory lamp glows until the called subscriber replies, when supervisory relay 200^W is energised around the subscriber's loop, due to the operation of the connector switching relay 1300^W, as explained under "connector," for calls from manual board. The earth is placed on the private lead in order to effect this condition, and so provide the best transmission circuits.

(13) The reason for placing the 200^W spool to earth on the B line until the supervisory relay is operated, is to enable the 48^v battery from connector line relay to remain operative, and so maintain the connection. It will be seen that the 200^W retard on the inner of the repeating coil is also connected to 48^v. Without the earth during the period of answer the release of the connector would be effected prematurely.

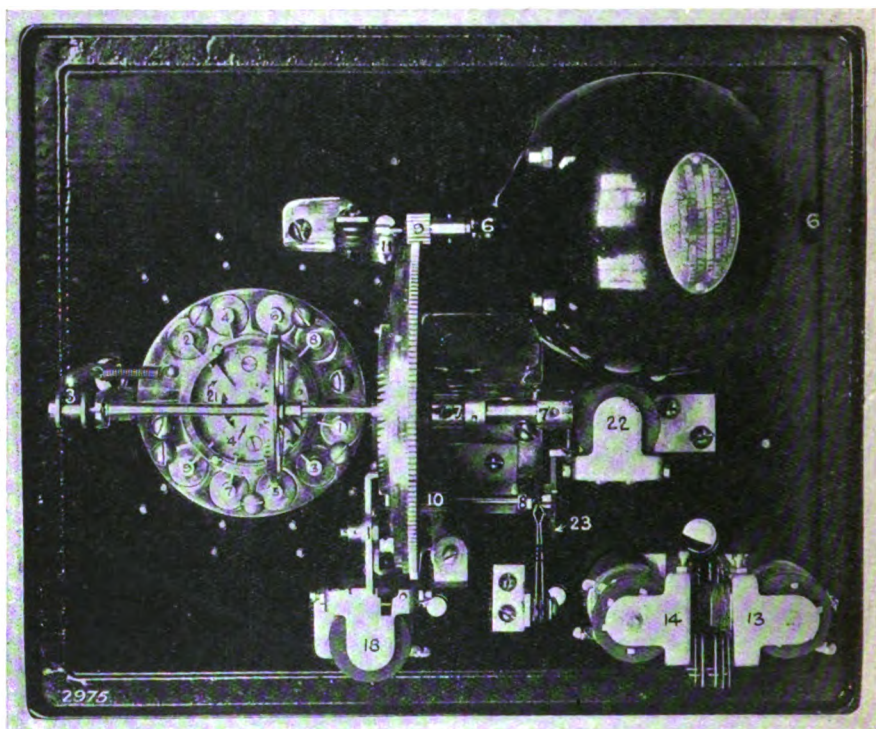
(14) It will be seen that the "cancel" button performs similar functions to the start button, and also disconnects the impulse circuit on the selector side. This enables the incorrect impulses to be cleared from the calling device machine without affecting the circuit connected.

(15) When No. 2 calling device machine is connected to the key-

AUTOMATIC THE STROWGER AUTOMATIC SYSTEM.

board, the three switching group relays are operated. Their release is effected by the 48^v connection on the 500^m relay, directly associated with the 1000^m relay, short-circuiting the latter when the "start" key is depressed.

9 and 10 shows the impulse machine. The mechanical operations in setting up a connection, say, for 1348, are: Button 1 depressed operates No. 1 monitor digit set-up solenoid once, also



9.—ELECTRO-MECHANICAL CALLING DEVICE MACHINE.

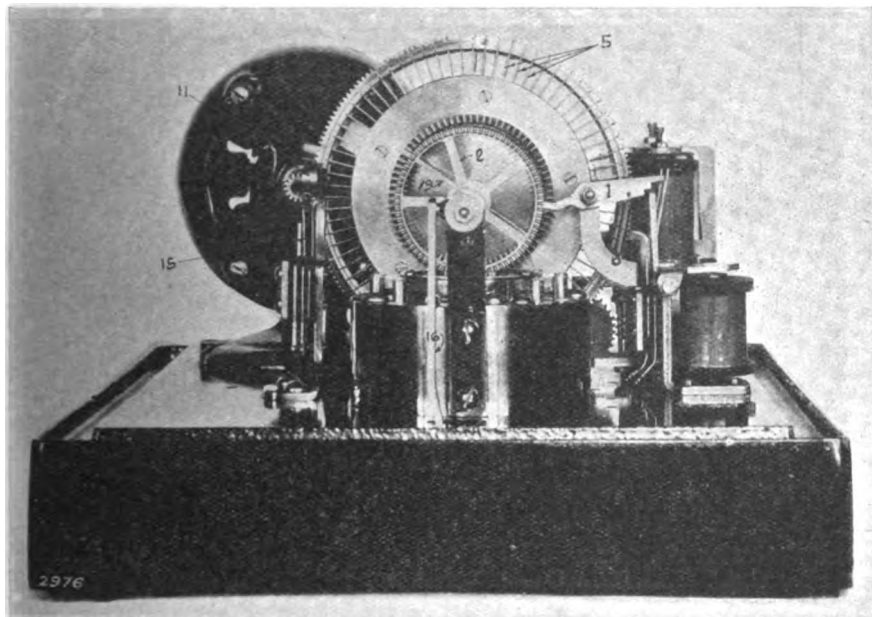
1 to 9. Monitor digit set up solenoids. 6. Motor bearing. 7. Pin wheel bearings. 8. Impulse cross-shaft bearings. 9. Motor pinion. 10. Impulse cam shaft pinion. 13 and 14. Slow release relays. 18. Starting relay. 22. Slow release magnet. 23. Star wheel.

operates digit relay, which pulls the crown wheel into the crown wheel pinion, and allows it to turn the set-up arm until it strikes the plunger of No. 1 monitor digit set-up solenoid. The crown wheel now disengages with its pinion wheel and returns to normal, at the same time setting out one pin in the impulse pin wheel.

The button 3 is next depressed, and the set-up arm travels to No. 3 monitor digit solenoid instead of No. 1 for first digit. This

allows the crown wheel to pass over No. 1 pin and set out No. 3 pin. Similar operations for figures 4 and 8.

When starting button *S* depressed, the starting relay operates and is mechanically locked, and white calling device lamp glows until call progressed to called subscriber. The starting relay completes the circuit of the motor, which drives the pin wheel until the pin that was set out by No. 1 button comes into contact with springs 15, energising slow release relay 14, which in turn energises slow release magnet 23 and slow release relay 13. The latter also closes the circuit



10.— ELECTRO-MECHANICAL CALLING DEVICE MACHINE.

1. Start relay locking arm. 2. Crown wheel. 5. Impulse pins. 11. Impulse pin replacing roller. 15. Pause springs. 19. Set up arm.

of magnet 23. This slow release chain is to hold the impulse circuit open until the selectors have had time to rotate. The operation of magnet 23 engages with the star wheel and holds the motor. When the circuit opens after delivering one impulse, the motor again drives the machine and delivers the next impulses (3), and so on. When all the numbers have been delivered the white calling device lamp will be extinguished, indicating to the operator that the device is ready for another call.

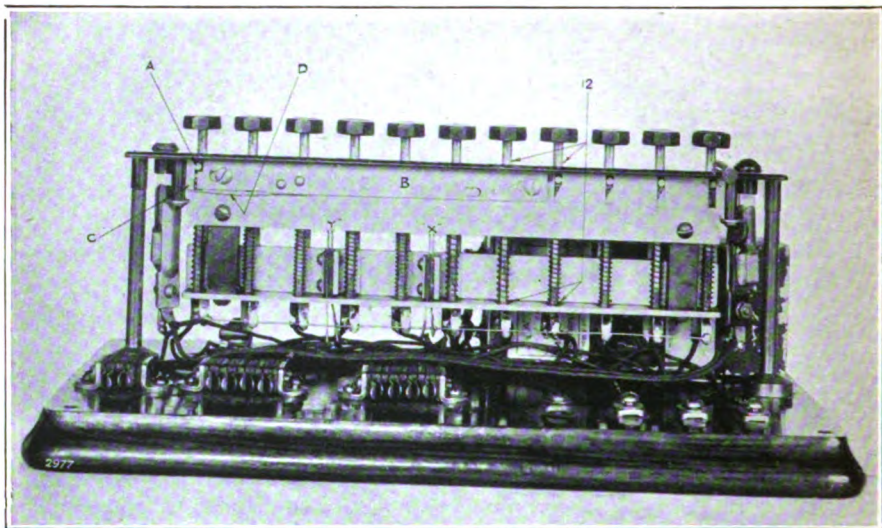
11 shows the button keyboard sender. The depression of any button operates shift bar *B*, which closes springs *X* and *Y*. The former reopens on the return of the button, and the latter remains

AUTOMATIC THE STROWGER AUTOMATIC SYSTEM.

closed as the small spring *D* is allowed to drop to the back of lug *C* until the the plunger *A* of the start button depresses *D* and restores the shaft bar *B*.

DIALLING-IN FROM MAGNETO EXCHANGES (NON-MULTIPLE) (12).

The scheme indicated is arranged for from all local area exchanges. The notes on the sketch indicate the method of operation. It will



II.—BUTTON KEYBOARD CALLING DEVICE.

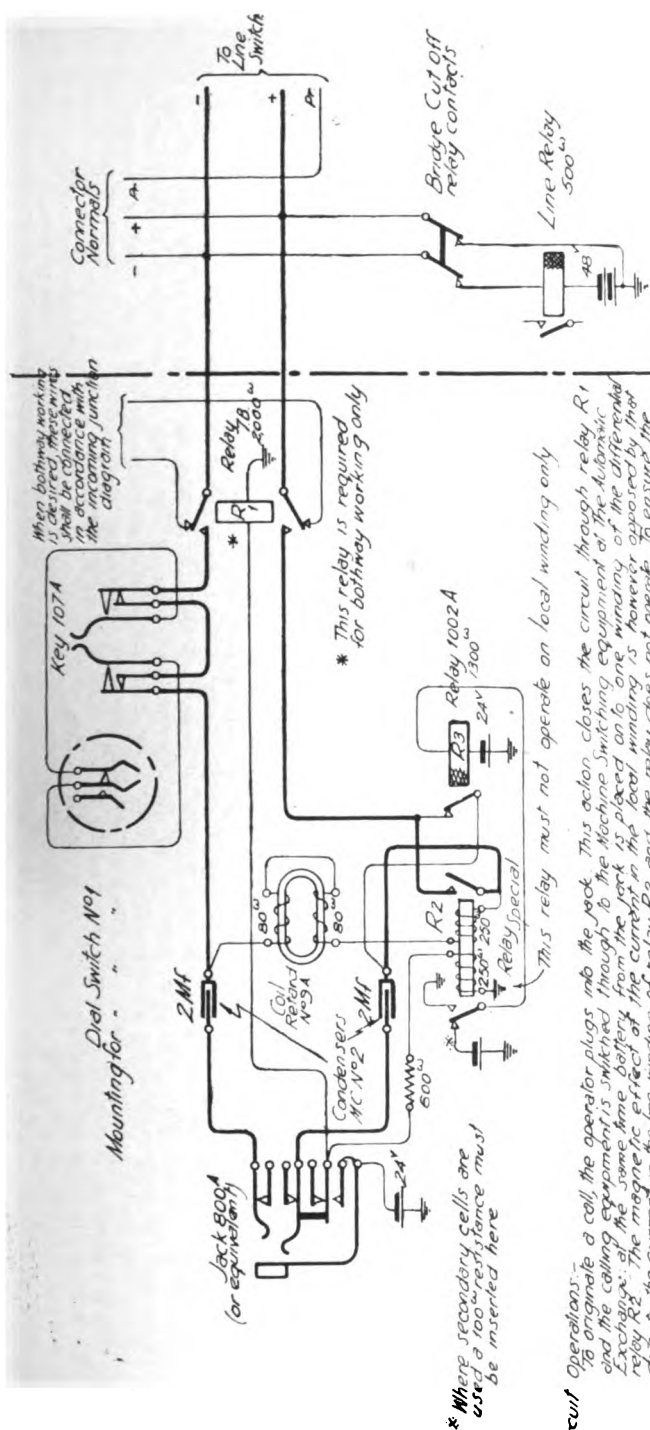
be noticed that the apparatus is associated with each junction, the latter terminating as a subscriber in the auto. exchange.

The back release of the called subscriber is arranged for in order that the latter may not be isolated in the event of slow clearing by the magneto exchange operator, which is liable to occur if the originating subscriber fails to ring off.

For magneto multiple exchanges, the cord circuits will be modified on the calling side in a similar manner, to give the necessary back-release condition, but the calling device will be associated with a dialling key in each cord circuit.

DIALLING-IN FROM C.B.S. EXCHANGES (NON-MULTIPLE) (13).

The scheme in general is similar to that for magneto exchanges, but the circuit is designed to afford standard supervision instead of back-release.

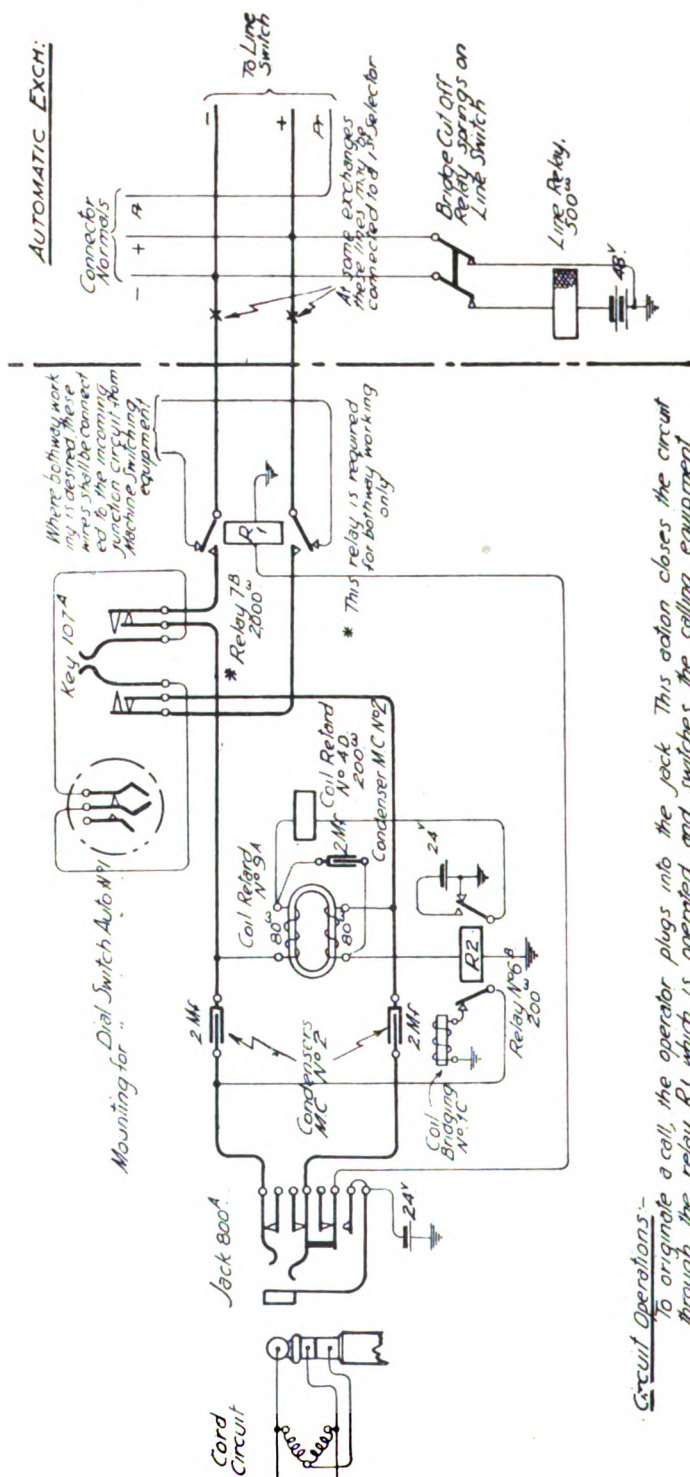


Circuit Operations:-

Operations: To originate a call, the operator plugs into the jack. This action closes the circuit through relay R₁ and the calling equipment is switched through to the Machine Switching Equipment at the Automatic Exchange. The magnetic effect of the current placed on to one winding of the differential relay R₂, reverses the direction of the current in the other winding is however opposed by that due to the current in the line winding of relay R₂ and the relay does not operate. To ensure the non operation of the relay it will be necessary to insert a resistance in series with the local winding. The value of this resistance is shown on the diagram. The operator now throws the number of the subscriber required when the called subscriber answers, the direction of the current reversed, and the two windings of relay R₂ now assist one another and the relay R₂ closes the circuit of relay R₃ and at the same time maintains the circuit through the relay R₂. Otherwise the circuit of relay R₃ and at the same time maintains the circuit through the relay R₂ reverses the direction of the line current and relay R₃ When the called subscriber hangs up, the releasing relay, is made to release even more slowly on account of the short circuit, and for a time sufficiently long to allow the automatic switch to be released.

2978

12.—DIALLING-IN CIRCUIT FROM NON-MULTIPLE MAGNETO EXCHANGE.



Circuit Operations:-

To originate a call, the operator plugs into the jack. This action closes the circuit through the relay R1 which is operated and switches the calling equipment through to the machine switching equipment of the Automatic Exchange. The insertion of the plug also closes a circuit through one winding of the Supervisory relay in the cord circuit which is therefore operated. The operator now throws the dialling key and dials the number of the subscriber required. When the subscriber replies, the currents in the line are reversed and relay R2 is now operated. The operation of relay R2 gives supervision to the C.B.S. operator and also places 2.4 on the line, thus ensuring the flow of equal currents in each line. Should the subscriber be busy, interrupted battery is placed on the positive line from the Auto. Exchange; this operates relay R2, at certain intervals and the busy flash will be given on the Supervisory signal. To release the connection the plug should be withdrawn.

2979

Both-way working is afforded by combining the line switch circuit with an ordinary outgoing junction circuit, and working the incoming calls at the distant manual exchange as ordinary jack-ended junctions.

AUTOMATIC SUBSCRIBERS DIALLING DISTANT EXCHANGES DIRECT (14).

In connection with the provision of small automatic equipments at rural exchanges, such as Chepstow, which will be unattended for long periods, back-release facilities on the connectors are afforded. A manual board is not fitted at this exchange, but arrangements are provided for automatic subscribers dialling distant exchanges similarly to subscribers' numbers. The explanatory notes on the sketch indicate the facilities afforded at the Lydney exchange, which is of the C.B.S. type, on the Chepstow-Lydney trunk circuit.

Both-way working is afforded by providing equipment at the manual exchange, as shown in 13.

Similar supervisory arrangements are provided on the manual C.B. board in the Newport auto. exchange on the Chepstow-Newport trunk circuit, by arranging for a loop and disconnection across the exchange side of the repeating coil, instead of earth and disconnection as shown.

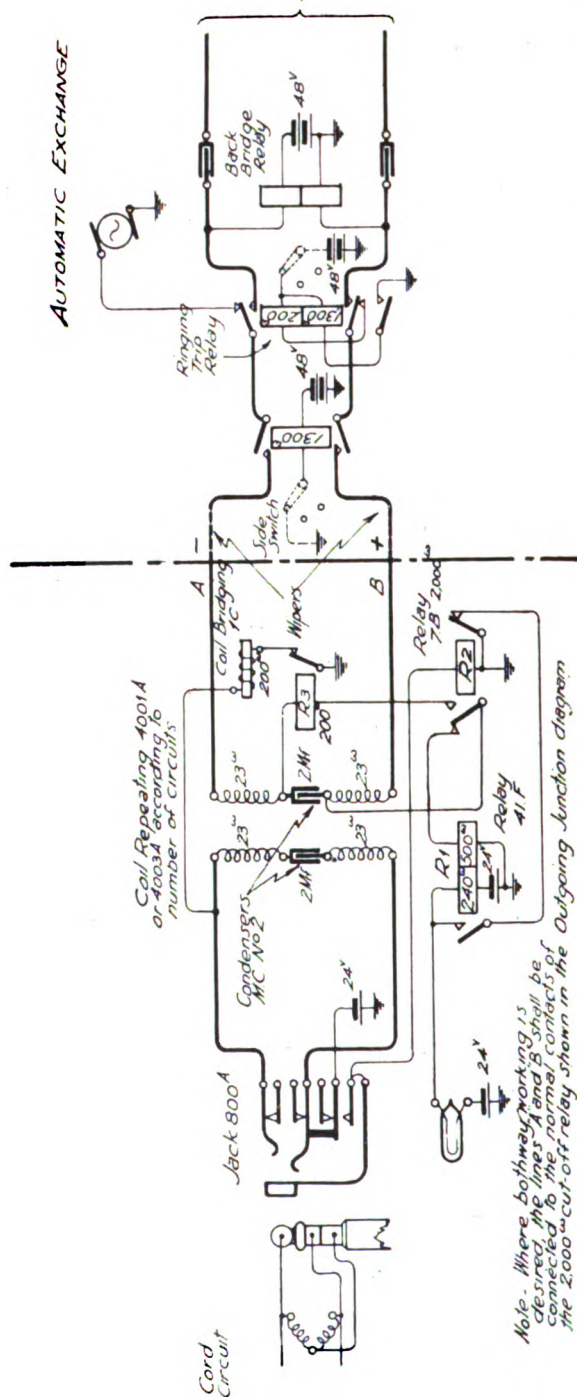
It will be evident that these circuit arrangements will be applicable for auto. P.B.X. switchboards associated with manual exchanges, when such is desired.

REPEATER FOR JUNCTIONS INCOMING FROM DISTANT C.B. MANUAL EXCHANGES (15).

Connected with the Leeds automatic exchanges are large groups of junctions from exchanges with C.B. cord circuits. Dialling-in direct will be arranged for. The circuit provides a pair of wires, devoid of apparatus throughout, for dialling direct to the first selectors, and a repeater for providing talking current to the called auto. subscriber. Standard supervision and busy flash are afforded to the originating exchange operator. This circuit will be used for circuits incoming from the Leeds Trunk Tandem and Toll exchange and Morley local exchange, and subsequently to other C.B. exchanges.

The operation is as follows:

(1) Operator dials and operates the selector line, relay, etc., in the usual way; relay *E* 100^w is also energised; then slow release relay *B* *via* 1300^w winding, thus earthing the release trunk *via* 26^w winding of relay *D* and engaging the connection. Relay *D* is inoperative at this stage.



2980

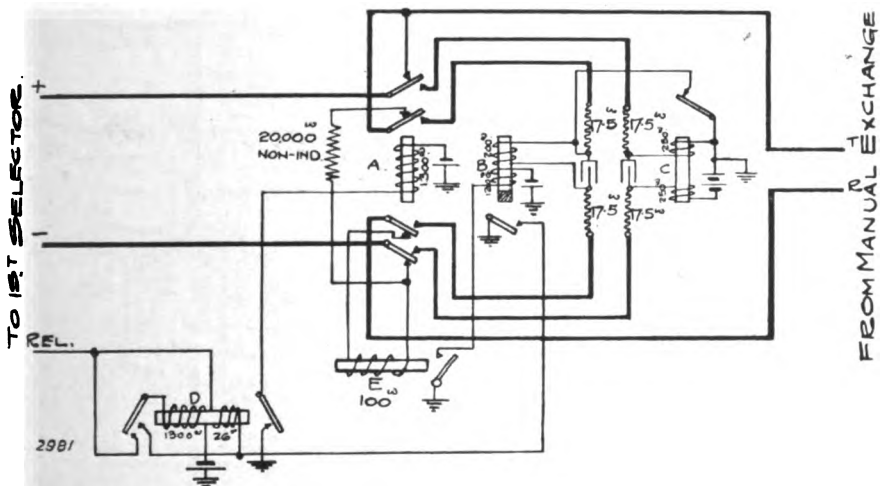
14.—CIRCUIT USED TO ENABLE RURAL EXCHANGE AUTOMATIC SUBSCRIBERS TO DIAL A DISTANT EXCHANGE OPERATOR.

(2) After dialling is completed, relay *E* is maintained until called subscriber replies, from battery and earth *via* connector line relay.

(3) When called subscriber replies, connector switching relay 1300^W operates *via* release trunks, 26^W winding of relay *D* to earth, operating latter, which locks, *via* 1300^W winding and places direct earth on release trunk during period of conversation.

(4) Relay *A* now operates, *via* earth on relay *D*, switching the subscriber through to relay *C*, which operates and supplies talking current to the called subscriber.

(5) Relay *E* is now disconnected, but relay *B* remains energised,



15.—REPEATER CIRCUIT FOR JUNCTIONS INCOMING FROM DISTANT C.B. MANUAL EXCHANGE.

via its 200^W winding from the distant C.B. cord circuit, the supervisory relay of the latter being operated.

(6) When called subscriber replaces receiver, relay *C* de-energises, and the earth on its armature now short-circuits the distant exchange supervisory relay to give the desired supervision. Relay *B* remains energised until the plug is withdrawn by the manual operator.

(7) If the called subscriber is engaged, interrupted battery from the connector is connected to the + line to operate the supervisory relay, and give the busy flash signal.

(8) The 20,000^W shunt has been found necessary to absorb the inductive kick from the 80^W + 80^W retardation coil in the Leeds-Toll cord circuit.

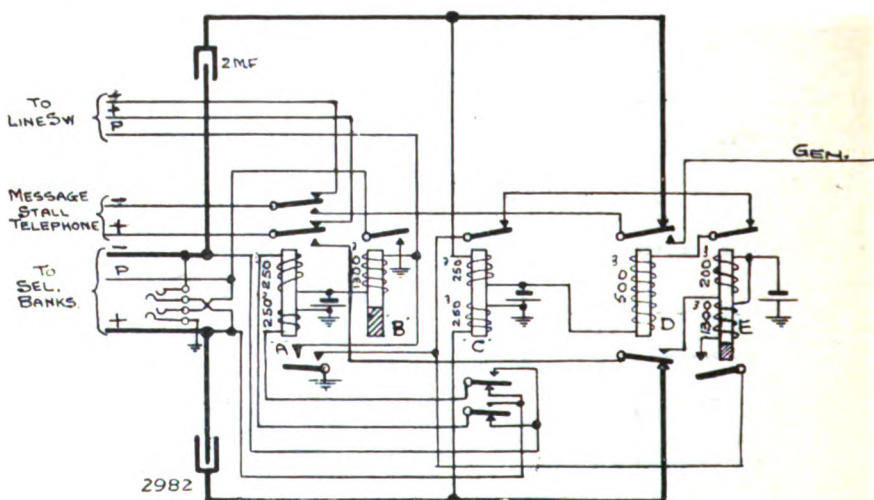
This circuit will be used for circuits incoming from C.B.S. multiple exchanges, by arranging for relay *C* to be fitted with an

additional armature, and wired to meet the conditions of the C.B.S. balanced battery cord circuit.

PHONOGRAM CIRCUITS (16).

At exchanges where the number of lines does not exceed ten, these circuits are connected up as P.B.X. subscribers. Where this number is exceeded, as at Leeds, a special repeater is provided and associated with a selector level as indicated. The operation of this circuit is as follows :

(a) Subscriber dials number allotted for telegrams ("90" in the case of Leeds), and finds an idle second selector.



16.— REPEATER CIRCUIT FOR PHONOGRAM LINES WHEN NUMBER EXCEEDS TEN.

(b) Relay *A* operates energising relay *B*, to place earth on private, and relay *D* to ring the message stall operator.

(c) Operator replies, energising ringing trip relay *E*, *via* 200^Ω coil, which locks, *via* 1300^Ω coil. Relay *C* now operates and supplies talking battery to operator and reverses the current in the originating subscriber's circuit to register the call.

Calls from the operator pass *via* the line switch in the usual way.

MULTI-OFFICE AUTOMATIC WORKING (17).

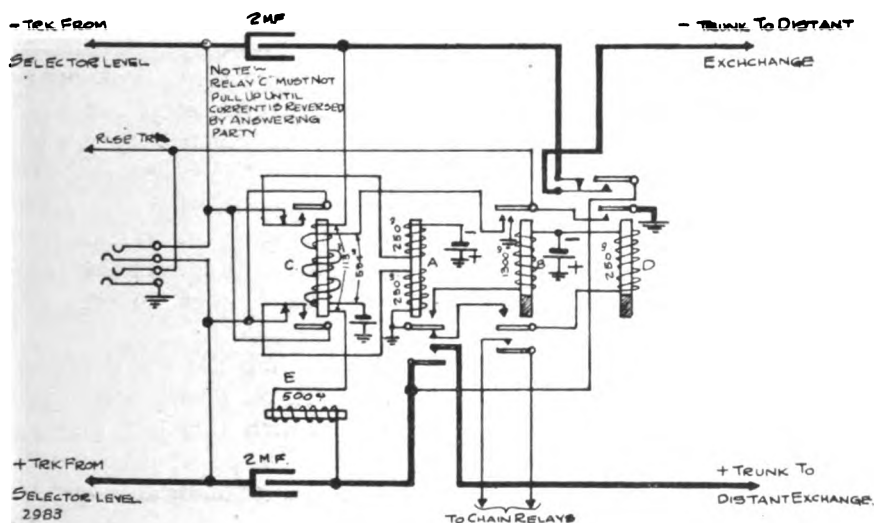
Auto. to auto. working is being provided for between the Accrington subscribers and Blackburn subscribers. The former have been allotted numbers 2000-2999 (with 3000-3999 for growth), and the latter 4000 to 6999 (with 7000-7999 for growth).

THE STROWGER AUTOMATIC SYSTEM. AUTOMATIC

(1) When an Accrington subscriber dials a number in the Blackburn series, or *vice versa*, the first digit pulled will associate his line and first selector with the repeater (17), which operates as follows:

(2) Relay *A* operates, then relay *B*. The former places a loop across the junction to operate the distant exchange second selector line relay $250^w + 250^w$. Relay *B* places the earth on the private and engages the first selector, and also completes the circuit for a chain relay set to record complete occupation of this group of circuits if desired.

(3) The second digit dialled transmits the desired number of



17.— REPEATER CIRCUIT FOR AUTOMATIC WORKING BETWEEN SUBSCRIBERS ON DIFFERENT AUTOMATIC EXCHANGES.

impulses to the distant exchange second selector by making and breaking the line contact of relay *A*.

(4) At the first break of relay *A*, relay *D* operates to cut out of the junction line circuit the resistance due to *E* and *C*, thus improving the dialling conditions to the distant exchange. In this manner the call progresses to the called subscriber on the distant automatic exchange.

(5) After dialling is completed, relay *D* releases. Relay *A* remains operative, and when the called subscriber replies, relay *C* is energised, so as to reverse the battery and earth connections on relay *A* and register the call on the calling subscriber's meter.

(6) When the originating subscriber clears, relay *D* maintains the earth on the private for a short period, until the release of the distant exchange automatic switches is effected.

TEST CONNECTOR CIRCUIT (18). (See page 168.)

One test connector is provided for each 100 lines, and for systems limited to a capacity for two or three thousand lines, these connectors are wired direct to jacks on the test desk. The jacks are labelled with the hundreds' number, and the test clerk is required to pick out the jack of the desired hundreds and dials the last two digits. This scheme is not satisfactory for larger exchanges, owing to the difficulty in accommodating the larger number of jacks required on each of the testing positions.

In such exchanges selectors, or distributors, have been provided between the test connectors. The distributor accepts the first two digits, and switches through to the test connector to deal with the last two digits. One distributor is provided for each test clerk's position. A jack with engaged signal for each distributor is multipled in front of each test clerk. For a four-figure system the test clerk will dial the full number. For a five-figure system, *e. g.* Leeds, each test clerk will require a distributor for each 10,000 lines. The last four digits will be dialled only by choosing the correct distributor. As all numbers at Leeds are in the 20,000–29,999 at the outset, one distributor only is required for each test clerk.

(1) Test clerk inserts the testing plug into the test distributor jack. The 1000^W relay operates, *viâ* earth on auxiliary springs of jack, and engaged signal lamp associated with this jack glows on all other test clerks' positions, but not on the position upon which testing-plug is inserted. Relay *A* on test distributor also operates; then relay *B* to prepare the circuit of the vertical magnet and relay *D*.

(2) Test clerk dials the first digit and relay *A* responds to impulses from dial, thus operating relay *D* and the vertical magnet. The latter lifts the wipers to the desired level. The private relay 100^W winding also operates *viâ* relay *D*. The latter relay releases upon the completion of the impulses, which de-energises the private relay and shifts the side switches to position 2.

(3) Test clerk dials the second digit, completes the circuit of the rotary magnet, and moves the wipers round to the test connector. If the latter be disengaged, the private relay releases and side switches move to position 3. Relay *E* of the distributor and connector relay *C* operate, *viâ* wiper *P 1*. Relay *E* locks, *viâ* its 3·8^W coil. Switching relay *C* 1300^W also operates, and switches the test jack through to the connector.

(4) Connector line relay *A* 250^W + 250^W operate, then relay *B* 1300^W to prepare the circuit of the vertical magnet and relay *D*.

(5) The clerk dials the third digit. The wipers are lifted to the

desired level, and on completion of the impulses the side switches move to position 2, etc.

(6) Test clerk dials the last digit; the wipers find the line required, and side switches move to position 3. Switching relay operates, *via* wiper *P*2, and earth on distributor relay *A*, thus providing a clean pair of wires from the test jack to the subscriber's line. If the line be free, the bridge cut-off relay of the called subscriber operates, *via* the private in parallel with relay *C* and relay *E* 3·8^W coil.

(7) Tests of the external plant can now proceed. For internal tests, a private control key is associated with the sleeve of the testing plug, which when depressed operates and places earth on relay *F* of the distributor. This relay operates and de-energises distributor relay *E*, connector relay *C*, and the bridge cut-off relay. Relay 1000^W, associated with distributor side switch 2, now operates, and the engaged signal lamp glows so long as the private control test key is thrown, thus indicating to the test clerk that the bridge cut-off relay has released, and that an external test is being made.

(8) This red lamp fulfils other functions:

(a) In the event of a test connector being already engaged by another test clerk (with distributor side switches in position 2, *i. e.*, immediately after the second digit has been dialled, but in advance of the release of the private relay), the wiper *P* 2 will find the earth on relay *A* of the engaged distributor with side switches in position 3, *via* *P* 2 to the engaged connector. This earth will enable distributor relay *G* to operate, energising 1000^W relay to complete circuit of the engaged red lamp. The private relay is also maintained to keep the side switches in position 2 and isolate wiper *P* 1.

(b) In the event of the called subscriber's line being engaged, the earth on the connector private will be to earth, thus short-circuiting distributor relay *E*, 3-8^W coil. The release of this relay also energises the 1000^W relay, and the engaged red lamp glows, indicating to the test clerk that he must refrain from testing. He may, of course, listen-in if desired.

(g) By depressing the holding key, the test clerk may hold the connection and proceed with other work if desired.

The operation of this key completes the circuit of the green lamp as a guard signal and also operates relay 1000^W to maintain the circuit of the distributor switching relay *C*, so that the release condition shall not exist.

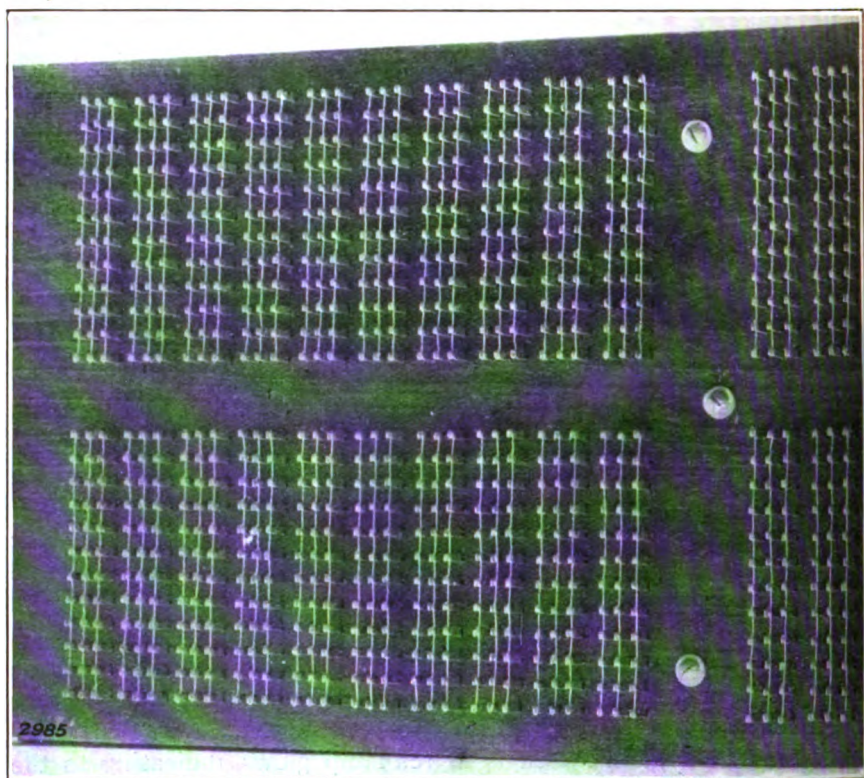
SELECTOR BOARD TERMINAL ASSEMBLY.

19 shows a view of a portion of the new terminal assembly, designed by the writer, for readily rearranging the number of outlets.

AUTOMATIC THE STROWGER AUTOMATIC SYSTEM.

The tags pass through a stout connection board from front to rear. The arrangement of tags is designed for the wiring from the various levels and selector shelves in groups two groups wide and ten high.

The rear is used for the wiring from the bank contacts of each level from each shelf, and for all permanent cabling, whilst the front affords a method by means of short jumper wires or "commons" for



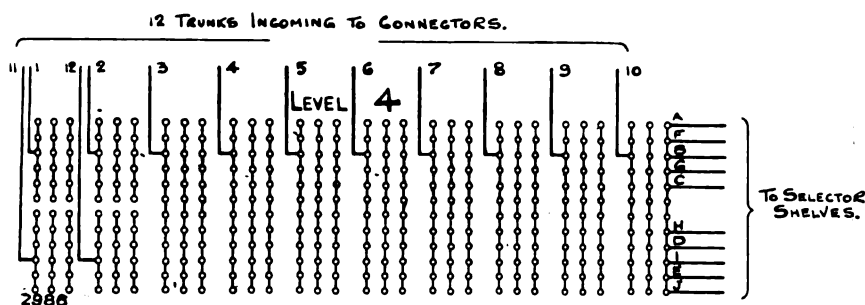
19.—SELECTOR BOARD TERMINAL ASSEMBLY (NEW STYLE).

varying the number of connectors per unit in a very simple manner. The scheme also renders it possible for "level" records to be kept, so that changes may be carried out according to simple instructions when necessary.

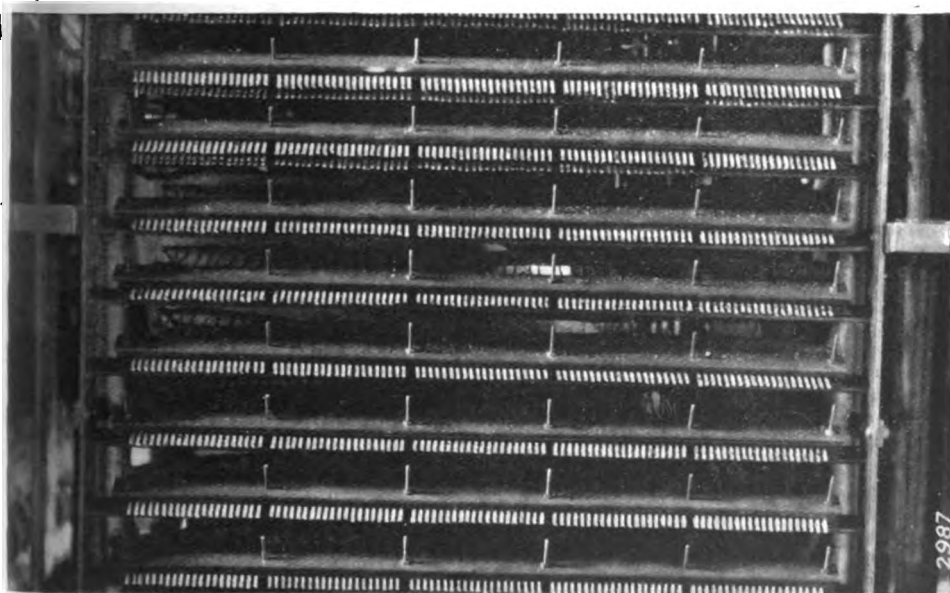
20 shows 12 per cent. trunking, *i.e.*, contact 1 and 2 have two outlets, each = 4, and the remaining 8 contacts one outlet only = 8. By cutting the common on contact 3, and jacking in another connector switch, 13 per cent. trunking can be arranged for, as cabling and wiring provide for 20 per cent. trunking. This new scheme is in use at Accrington, Paisley, Leeds, and Blackburn.

THE STROWGER AUTOMATIC SYSTEM. AUTOMATIC

2I shows a view of the old terminal assembly. The terminals are fragile, separated by thin sheet fibre, and then clamped in a slanting direction between clamping irons. The sets of terminals vertically



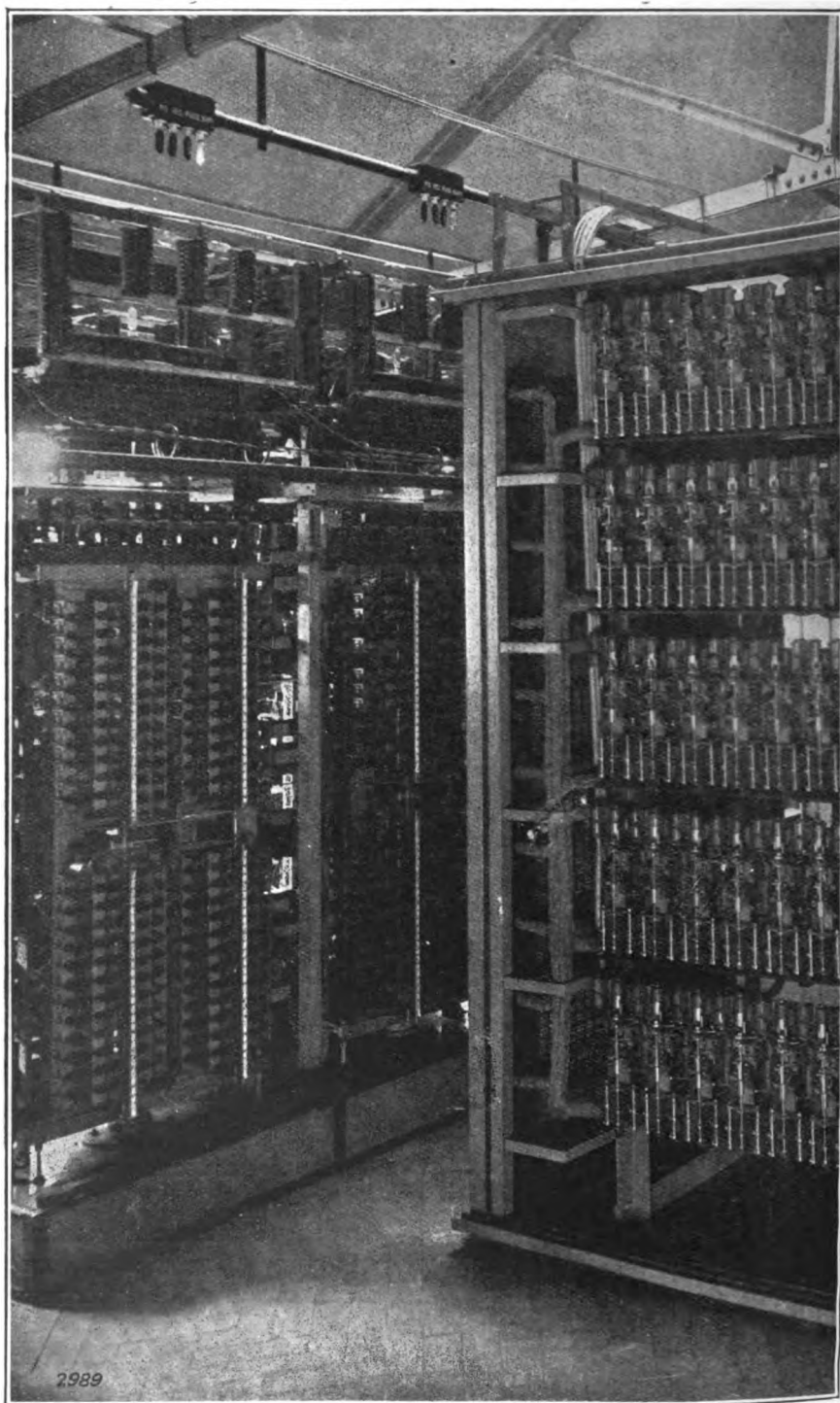
20.—TERMINALS ON SELECTOR BOARD ASSEMBLY SHOWING LEVEL 4 WIRED FOR 12 PER CENT. TRUNKING.



21.—SELECTOR BOARD TERMINAL ASSEMBLY (OLD STYLE).

are pinched and soldered together according to the scheme desired. Variations are affected by unsoldering and running in short connecting leads. The scheme is unsatisfactory for making changes, and does not lend itself to the preparation of "level" records. This scheme is in use at Epsom, Official Switch, Newport and Portsmouth Exchanges.

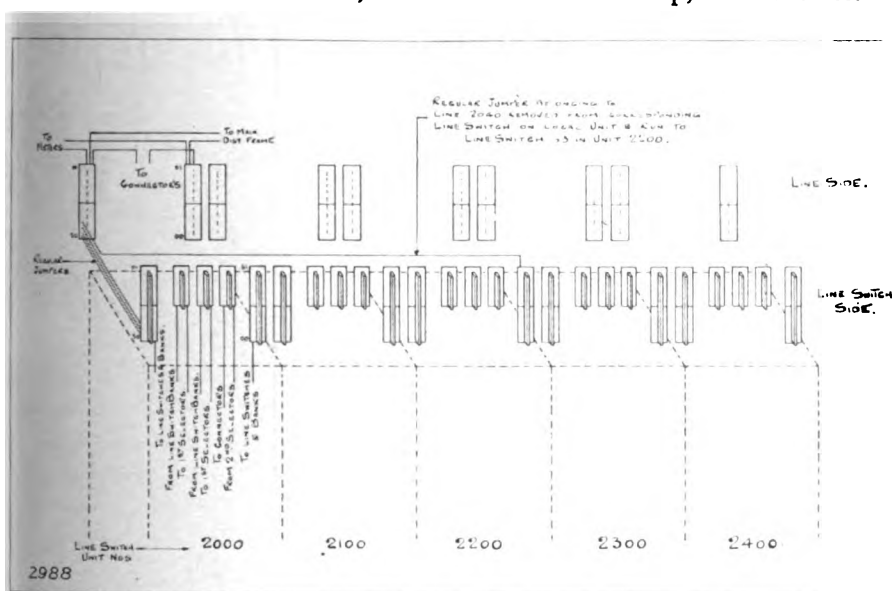
AUTOMATIC THE STROWGER AUTOMATIC SYSTEM.



**22.—PRIMARY LINE SWITCH UNITS ON LEFT, SELECTOR BOARD ON RIGHT.
ACCINGTON EXCHANGE.**

CROSS CONNECTION FACILITIES ON LINE SWITCH UNITS.

22 is a view of a portion of a first selector board, with two line switch units to the left. The latter indicates the arrangement of the terminal strips on the top of the line switch side of each unit for the purpose of cross-connecting. The two strips at the sides each accommodate the wiring from twenty-five line switches, *i. e.*, fifty for the left and right of the unit respectively. Two of the centre terminal strips are connected with the bank contacts of the line switches and first selectors, ten circuits on each strip, from the left



23.—STRAIGHT LINE DIAGRAM ILLUSTRATING CROSS CONNECTION FACILITIES ON LINE SWITCH UNITS.

and right groups of fifty line switches. The remaining terminal strip is cabled to the connector switches and second selectors.

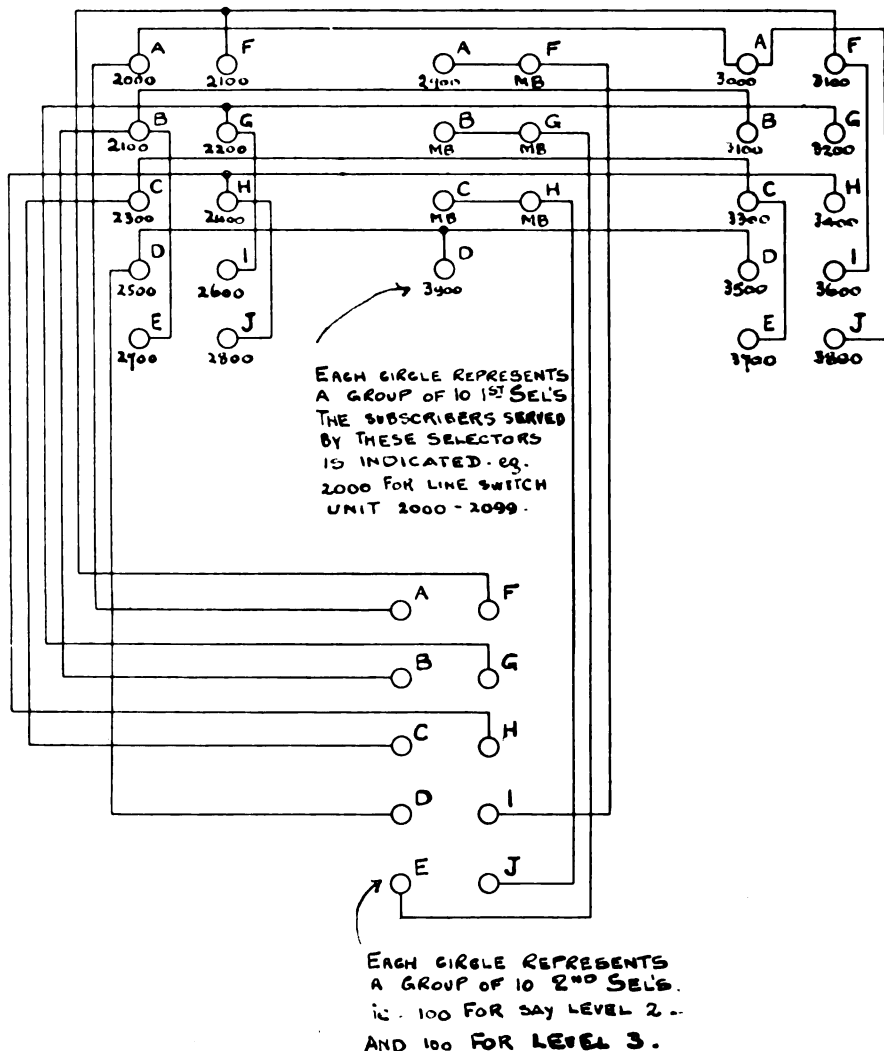
23 shows a straight line diagram of the circuits terminating on line switch units, which will explain the foregoing more clearly. This sketch also indicates the position on the connector side of the unit of the terminal strips accommodating the line side of the circuit.

Four terminal strips, each for twenty-five circuits, are fitted on each 100 line unit. A typical example of cross-connecting is shown, from which it will be evident that any subscriber's number can be associated with any line switch according to the traffic requirements.

The trunking arrangements outgoing from the line switch banks provide cabling for ten circuits from each of the two banks opposite the two rows of fifty line switches. These wires terminate on the two

AUTOMATIC THE STROWGER AUTOMATIC SYSTEM.

centre terminal strips, from which permanent cabling is provided for twenty outgoing trunks to first selectors or secondary line switches,



Each line represents a group of 10 trunks.

2990

Each letter represents a selector shelf.

24.—LEVEL DIAGRAMS INDICATING OUTLETS FROM FIRST TO SECOND SELECTORS.

as the case may be, *via* the main, manual, and auto. I.D.F. Should 10 per cent trunking only be provided at the outset, trunks 1 and 2, 3 and 4, etc., will be commoned by bare copper wire on the adjacent

terminals of the line switch terminal strip. If more than 10 per cent. be required, a "common" is removed and an additional selector jumpered in on the main I.D.F.

LEVEL DIAGRAMS.

Switching scheme diagrams are provided for each exchange on similar lines to that illustrated for the Epsom exchange. These fully indicate the scheme provided, but in order to appreciate the outlets available troublesome tracing is required. 24 shows a typical "level" diagram introduced by the writer, in connection with the discussion of switching scheme diagrams. These level diagrams show clearly the first selectors sharing, or having sole access to a subsequent group of second selectors, and enable the grouping arrangements for each level to be followed with ease.

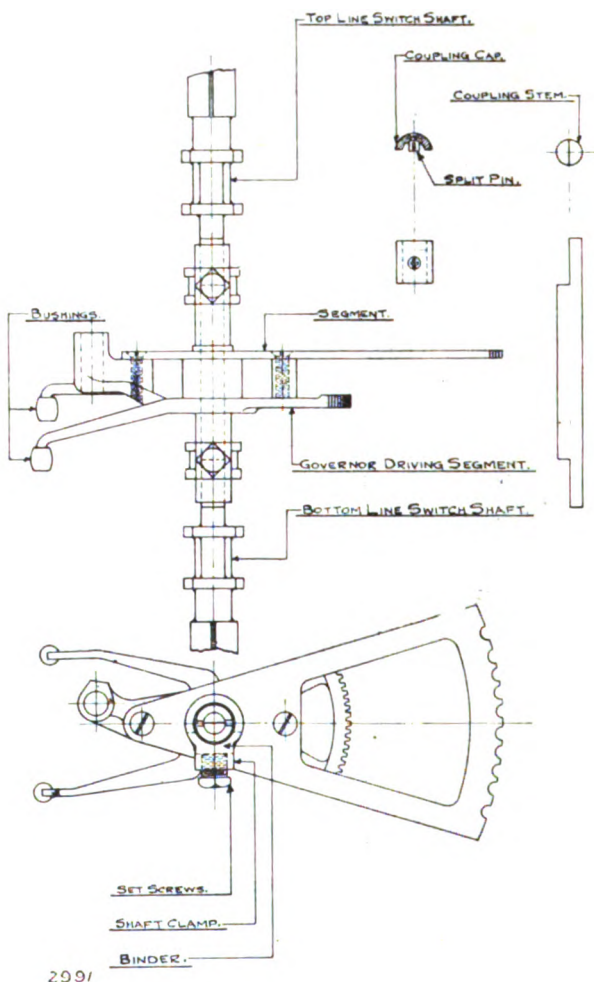
GROUPING OF MANUAL BOARD SELECTORS.

For each of the manual board junction jacks outgoing to automatic, which are used for completing trunk and junction calls, a first selector is allotted, *e. g.* *F, B, G, C,* and *H,* are directly associated with fifty jacks. In order that manual board calls shall always progress through to the last selector, the operators are instructed to use a certain set of jacks for calls to the 2000 series of numbers, and another set of jacks for calls to the 3000 series of numbers, *e. g.* assume the level diagram related to the second level and third level, *i. e.* 2000 and 3000 series of numbers, operators will use the jacks associated with the twenty first selectors on shelves *B* and *C* for 2000 and shelves *G* and *H* for 3000. The ten selectors on shelf *F* are available for calls to either of these groups.

It will be evident that a call to a 2000 subscriber can be obtained *via* selectors *G* and *H,* but by arranging for the operators to select an extravagant provision of second selectors is avoided, and the maximum use is made of the apparatus. The main advantage of this arrangement is, however, to enable operators to place more reliance on the progress of the call, after dialling the number, a condition which would not otherwise be afforded unless a second selector was provided for each first selector, as the operator is not able to discriminate between (1) a call which has actually controlled the subsequent switches and reached the desired subscriber, but the latter has not replied, and (2) a call which has failed at some point to find an idle selector, or one which has incorrectly progressed due to lack of second selector switches and found the wrong subscriber.

This latter case may be of rare occurrence, but the first condition will happen fairly frequently, and the operator would incorrectly

record the second case as no reply, which in the case of an important trunk call may result in a serious complaint. It is of course assumed that sufficient connectors are provided for the traffic incoming to the subscribers on each unit.



25.—SCHEME FOR READY REMOVAL OF MASTER SWITCH.

READY REMOVAL OF MASTER SWITCH (25).

25 shows a scheme devised for removing a master switch without interfering with the line switches. The master switch is mounted on the line switch shaft, between the top and bottom twenty-five line switches. A coupling stem is now provided, and is clamped to the shaft by set screws, which in the event of a change of master switch

being necessary can be easily unscrewed and the master switch withdrawn, an operation which was hitherto very cumbersome.

NUMBERING SCHEME FOR AUTOMATIC EXCHANGES.

In tracing faults it is necessary to ascertain quickly which switches are in use on the connection, and it is essential, therefore, for the various switches to be numbered in such a manner that it will be possible to determine with ease from any switch the subsequent or previous switch involved in the connection. The scheme devised is as follows:

The position of each line switch in the hundred is designated by a permanent label. The subscriber's telephone number is designated by a removable ivoride label with black filling.

Each left and each right shelf of a primary L.S. unit carries a chart. The purpose of the chart is to show at a glance to what individual first selector the trunk from any line switch bank contact goes. The meaning of a typical trunk code, "1. 2. G. 6.," is as follows:

1 = First selectors.

2 = Second group.

G = Selector shelf.

6 = Number of switch in shelf.

Where secondary line switches are fitted the following is a typical combination: "Div.: 18. 14."

Div.: = Secondary lines switch division.

18 = Number of division.

14 = Number of switch in this division.

Each connector switch carries one spring clip label engraved with the number of the connector. The label for the test connector is engraved "T" and that for the trunk offering "O."

A chart is fitted on this side of the line switch unit showing all the second or third selectors having access to each connector mounted on the unit. Each connector has a code associated with it, e. g., "2. 2. D. 1-10." the meaning of which is as follows:

2 = Second selectors.

2 = Second group.

D = Shelf.

1-10 = Switches 1-10.

This signifies that, together with switches on other shelves, switches 1 to 10 on shelf D. of second selectors, second group, all have access to the connector shown at the top of the column.

Each half of a secondary line switch shelf—upon which no more than twenty-five secondary switches are mounted—is termed a *Division*.

The divisions are numbered from 1 upwards throughout the secondary units.

Each secondary line switch carries a label with red filling, to indicate the incoming trunk terminating on the switch, *e. g.*, "29. L.R. 5."

29 = From the 29th hundred primary unit.

L.R. = From both left and right shelves.

5 = Bank contact No. 5 in both shelves.

Each side of a selector board, with a capacity for 100 selector switches, is termed a "group."

Each switch is fitted with a label engraved with the number of the switch in the shelf (1-10).

Each switch also carries a label, to indicate the trunk having access to the switch, *e. g.*, "27. L.R. 5":

27 = The hundred number of the primary line switch unit.

L.R. indicates 10 per cent. trunking on that primary line switch unit, *i. e.*, this trunk originates from the left and right shelf banks.

5 = Number of the bank contact on the primary line switch unit on which the call originated.

Where secondary line switches are fitted a typical label would be "Div. 25. 7":

Div. = Secondary line switch division.

25 = Number of secondary line switch division.

7 = Number of trunk from this division.

Each set of ten first selectors carries a chart to indicate where the trunks outgoing from the bank contacts of each level of each switch terminates.

The chart is divided into two parts. The first part shows where the 100 trunks from the first switch in a shelf of 10 terminate, and the second part shows the allowance to be made for the slipped banks when any but the first switch is under consideration.

A typical code in this chart is "2. 3. F. 2."

2 = Second selectors.

3 = Third group.

F = Shelf.

2 = Second switch in shelf F.

For second and third selectors each switch is fitted with a label showing the number of the switch in the shelf (1-10).

Each shelf of 10 switches carries a chart.

26 is a typical example. The code at the side "2. 1. A." indicates second selector group 1, shelf A. Under heading "Incoming Chart" is shown for each switch the first selectors having access, say, "1. 2. A. 1-10" denoting first selector group 2, shelves A. and F., bank contacts 1 to 10. Under heading "Outgoing Chart" is indicated where the 100 trunks from the bank contacts of the 10 levels terminate,

THE STROWGER AUTOMATIC SYSTEM. AUTOMATIC

e.g. level 0, contact 1 for the first switch finds 20/1, *i. e.* 2000–99 group of subscribers connector switch 1. Level 9, contact 1, for the first switch finds D.L. 1, *i. e.* dead level circuit 1 on the manual board.

Heading “Multipling of Contacts” indicates that if the fault is

[illegible]

26.—CHART FITTED ON SECOND SELECTOR BOARDS TO ENABLE CALLS TO BE TRACED BACKWARDS AND FORWARDS.

being traced from switch 7, contact 1, the fifth contact of the outgoing chart will refer. This chart is therefore a ready means for indicating the slipped bank wiring.

It will be recognised from the foregoing that many problems have been encountered in connection with the introduction of the automatic telephone system into the service of the British Post Office.

The developments obtained up to the present have been the

result of close co-operation between the engineers of the Automatic Telephone Manufacturing Company and of the Post Office. It would be idle to say that the end of such progress has been reached. The subsidiary I.D.F. on the line switch units, the new terminal assembly, the improved master switch, etc., have all been necessary on account of the system and lay-out of the plant in self-contained line switch units and selector boards.

The lines of progress in future will probably be the introduction of—

(1) A rotary form of line switch which will enable the master switch to be dispensed with, and the subsidiary I.D.F. to be displaced by terminal strips on the main *I.D.F.*

(2) Selectors and connectors mounted on racks instead of in self-contained boards.

In conclusion, the writer is indebted to the Automatic Telephone Manufacturing Company for the photographs and loan of drawings illustrating this article.

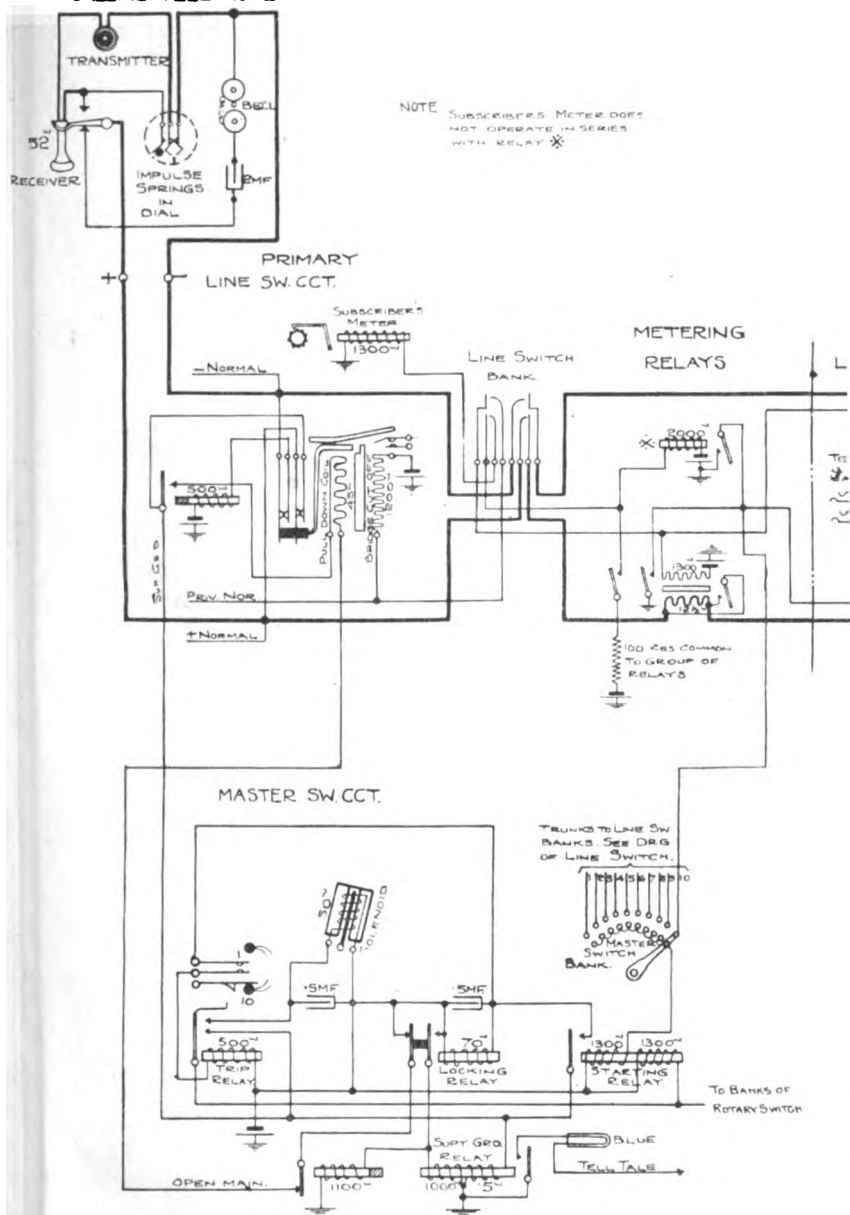
ENGINEERING CONTRACTS.

By W. LAWS.

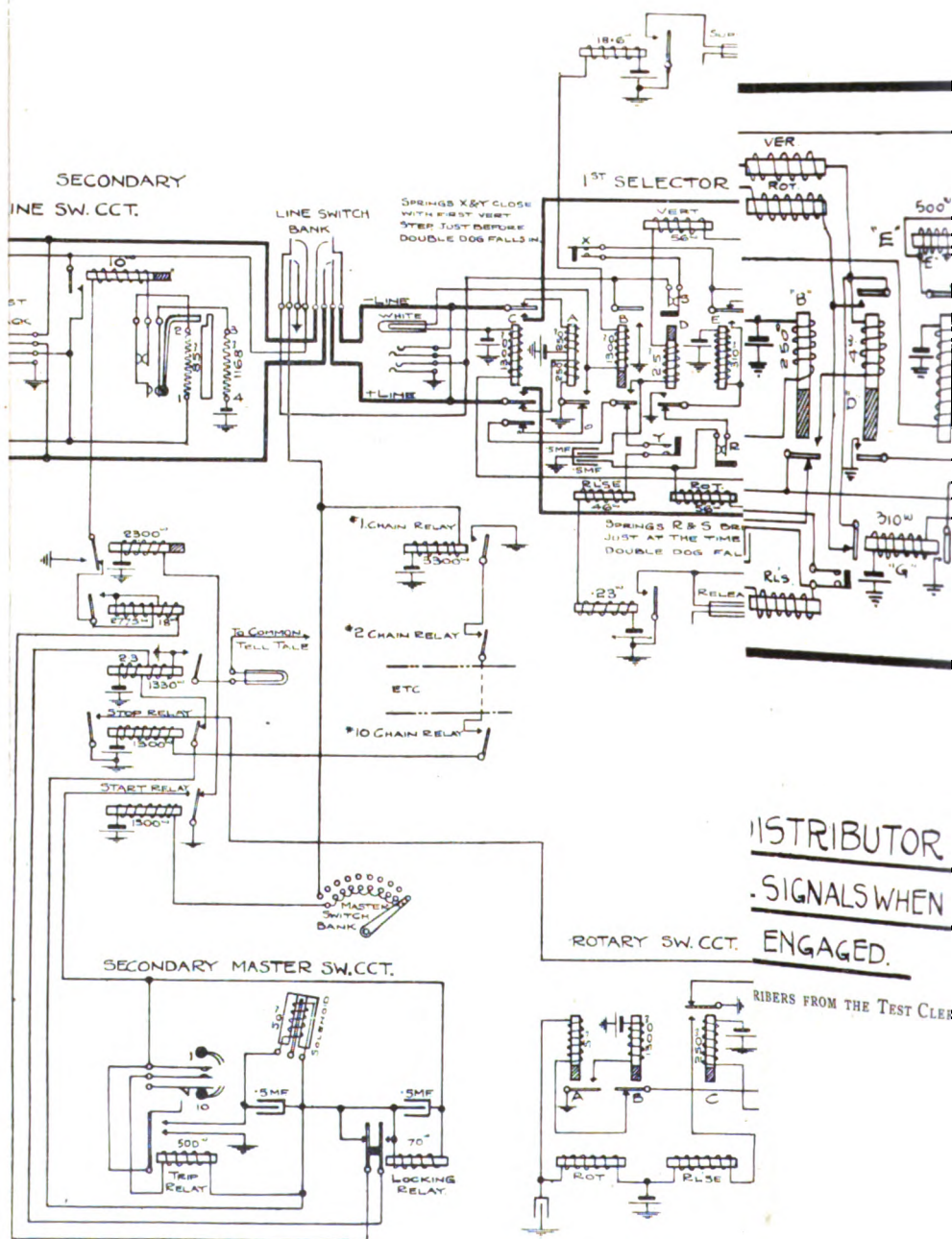
A CONTRACT has been defined as an agreement enforceable at law, made between two or more persons, by which rights are acquired by one or more to acts or forbearances on the part of the other or others. Its legal character makes it a binding agreement, the breach of which by either of the parties concerned sets up a new obligation, conferring a right of action upon the party injured by the breach. To all those, therefore, who are called upon to deal with contracts, either in their formation or in their performance, a careful study of the elements necessary to a valid contract is essential. One cannot hope to deal with such a subject at all comprehensively within the limits of a magazine article, but one can, perhaps, suggest certain considerations which will help to secure effectively, and with as little friction as possible, the objects for which contracts are created.

Briefly stated the essentials of a contract are: (1) a distinct communication by the parties to one another of their intention, *i. e.* offer and acceptance, and (2) the presence of certain evidence required by law of the intention of the parties to affect their legal relations. The controlling factor is always the "intention of the parties"; it is the "polar star" in the interpretation of all contracts; once ascertained it will prevail. The expression of that intention should, therefore, be made in terms so clear that the inten-

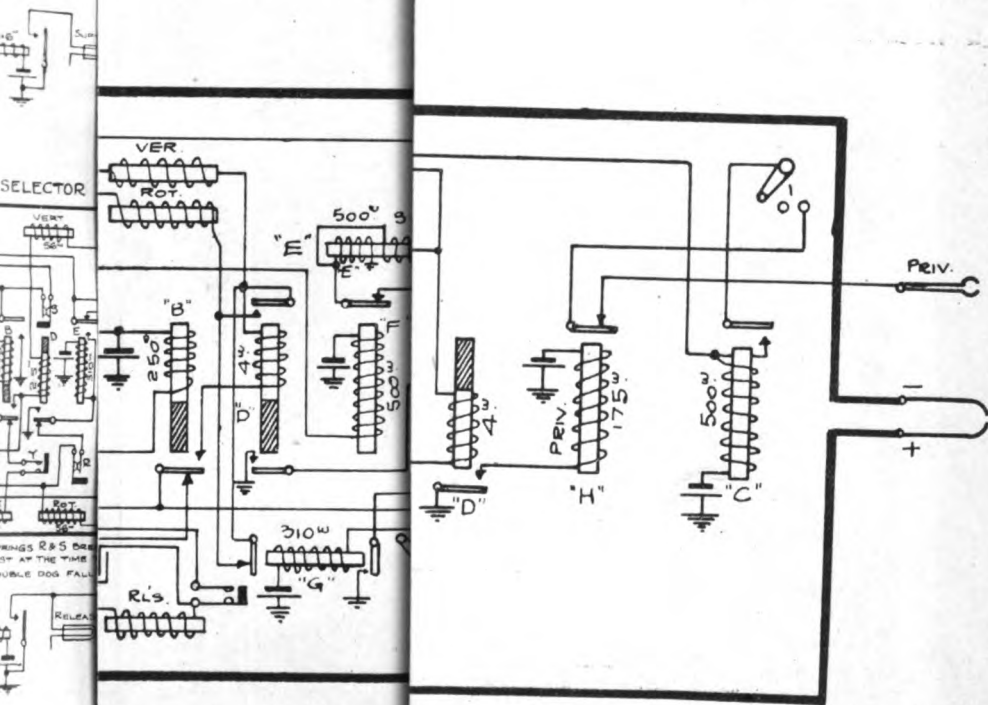
CALLING TELEPHONE



2967

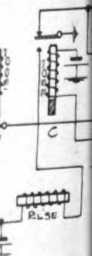


I.—CIRCUITS INVOL

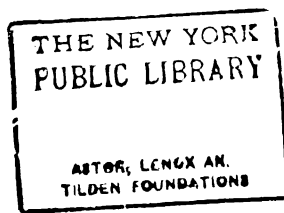


DISTRIBUTOR SWITCH CIRCUIT
SIGNALS WHEN DISTRIBUTOR SWITCH
ENGAGED.

RELAYERS FROM THE TEST CLERK



CIRCUITS INVOLVED



tion cannot be misunderstood. In engineering contracts the intention of the party seeking to enter into legal relations with the contractor is expressed in the specifications, plans, and drawings upon which the contract is ultimately based. The careful preparation of these is, therefore, a matter of first importance. It is one thing for an engineer to prepare plans and specifications for a work for the execution of which he can assume absolute powers of direction and control; it is quite another—an infinitely more difficult task—to prepare these descriptions and directions with such clearness and completeness as to require no further explanation to the contractor. In one case he can rely upon his own knowledge—expressed it may be in the vaguest terms—to “see the job through,” overcoming obstacles as they arise, meeting no troubles half-way; in the other he must, whether he likes it or not, rely upon the specifications and plans furnished to the contractor before the work is commenced, and any departure from which on his part, just as much as on the part of the contractor, constitutes a breach of contract which cannot in all cases be easily remedied. The absolute necessity of clearness, definiteness, and exactness of expression in the documents which are to be—or which ought to be—the sole guide to the contractor in the execution of the work, cannot be too strongly urged. Most of the difficulties and much of the conflict between the parties to the contract could, I venture to suggest, be avoided by a more careful preparation of plans and specifications. More disputes arise out of misunderstandings than out of clear mistakes. The ideal specification is capable of one reasonable interpretation only. The contractor should be offered no opportunity of misinterpreting the conditions and requirements of the contract. If they are offered he will probably take them if he is likely to benefit thereby. He will not persist in any interpretation which is not reasonable. He knows that in the settlement of all such disputes by parties outside the contract the most reasonable construction must always prevail. But he will persist if the ambiguity of the specification permits two equally reasonable—but totally different—meanings, and his view will probably be upheld. As a rule words are construed more strongly against the party using them.

And if the first desideratum be that the directions to the contractor and the general requirements should be made clear, it is of almost equal importance, at any rate to the engineer and the firm or body for whom he is acting, that they should be comprehensive. This does not mean merely that the specifications and plans should describe definitely and in detail the site of the work, the quality and process of manufacture of the materials, and the method of installation of the finished plant. They should include, in addition to the purely legal essential elements of any contract, general clauses

providing for payment, possible cancellation or abrogation of contract, enforcement of liquidated damages, sub-letting, rejection and re-examination of imperfect work, times for commencement and completion of work, etc. They should, moreover, make specific provision for all contingencies which are likely to arise and which would materially affect the agreement, stating clearly how such eventualities are to be met. And, generally speaking, they should provide for a definite result, looking to the accomplishment of an end rather than to the means of its attainment. In certain cases such provision is, of course, quite unnecessary. Experience may have proved beyond all doubt that certain results can be achieved and can be best achieved by the adoption of certain methods, and in such cases it is sufficient to specify only the methods. But it has to be remembered that, in such cases, the contractor accepts no responsibility in respect of the result achieved. For this reason it is preferable to leave the contractor free either to adopt whatever methods he may think best calculated to achieve the results required or to suggest alternative methods to those stipulated. A good contractor who is a specialist in a particular class of engineering work may wish to introduce methods of construction better than those conceived by the engineer responsible for the specification. And, finally, the specification should state clearly the conditions which shall obtain in the event of altered requirements or extra work being found necessary during the performance of the contract. The necessity for some such provision must be quite obvious. In its absence, any departure from the requirements stipulated would render the contract void. Only the perfect specification could dispense with such provision, and one fears that it has yet to be prepared. It is scarcely sufficient, moreover, to secure the right to alter or add to the work specifically tendered for. If extra work is contemplated, the extent of which cannot possibly be determined in advance, the greatest care should be exercised in defining clearly what shall constitute such extra work, on what basis it shall be paid for, and how far its performance shall be governed by the conditions, general and specific, applicable to the work which is the subject of the original contract. The contractor should be definitely prohibited from undertaking additional work except on the written instructions of the other party to the contract, or of the representative expressly authorised by the contract to give such instructions. It should be remembered that, especially on construction contracts, controversies regarding payment for extra work are the chief source of litigation, and these controversies usually arise from the failure of the plans and specifications, either to describe properly and sufficiently the work to be done by the contractor or to prescribe the terms and conditions under which additional work may and shall be undertaken

and paid for. Most contractors will take advantage of any inadequacy in the provisions of the specification in these respects to secure as much additional work as possible at prices which they are in a better position to dictate after the contract has been placed in their hands. It is, perhaps, scarcely necessary to add that all the provisions of the specifications and drawings should be considered in relation to each other to ensure that the requirements, terms and conditions which shall govern the performance of the contract are consistent and afford no opportunity for conflicting interpretation.

Regard should always be paid in the preparation of the specific and general clauses embodying the requirements of the contract, to the securing of the best results consistent with sound economy and with what is considered, from an engineering standpoint, good practice. In this connection two considerations are perhaps worthy of mention. Unduly exacting requirements and harsh and unreasonable conditions should be avoided. They may result in a financial outlay out of all proportion to the object desired. It is wise, in order to avoid trifling and frivolous claims for extra work to make the contractor meet all likely contingencies and overcome all reasonable obstructions as part of the contract proper; but if a contractor is required under the same conditions to provide for all conceivable happenings and hindrances, these requirements will, in nine cases out of ten, be dearly paid for. And further, having regard to the nature of the particular work, consideration should be given to the relative merits of what are usually known as the "actual cost plus percentage" and "fixed price" forms of contract. In an ideal state of society, the former would prove the fairer and better method for both parties. On the one hand it avoids the payment for contingencies which may never arise, obstacles which may never be encountered, hindrances which may never be suffered, and accidents which may never happen; while it relieves the contractor of risks and responsibilities for unforeseen obstructions and difficulties, and thus provides that, while he may never live to be a millionaire, he need not die in the workhouse. In the case of some public bodies, and even private contractors, this is the only basis on which they are prepared to undertake certain classes of work involving risks and responsibilities, the nature and extent of which cannot be determined in advance. But this method, while it may occasionally prove to be the more economical in such cases, cannot be recommended for general adoption. It demands the closest and most competent supervision and the most scrupulous integrity, alike on the part of contractor and supervising engineer in the face of great temptation. For these reasons the "fixed price" method is generally preferred.

Having completed the plans and specifications, the invitation of tenders can be proceeded with. The selection of a sufficiently large number of competent contractors is a matter of importance—from the standpoints of economy and efficiency—which need only be mentioned to be appreciated. Care should of course be exercised also to secure that the work shall be carried out under the most favourable conditions. In this connection the state of the market regarding both materials and labour required for the particular work under consideration should be carefully watched, and, where possible, the invitation of tenders should be deferred until the most advantageous conditions obtain. Similar regard should be paid, in the case of works to be carried out in public thoroughfares, to traffic considerations and the choice of times for the execution of the contract which will involve the least possible interference. Where all other conditions are favourable, advantage should also be taken of longer daylight and drier weather. And in order to reap the benefit of these conditions all preliminary arrangements for the execution of the work should be completed before tenders are invited, to ensure that as little time as possible shall elapse between the invitation of tenders and the commencement of the work. Such a precaution is, moreover, due, in fairness, to the tenderer, who may reasonably assume that it is the intention of the party inviting the tender to have the work carried out forthwith, and who may, therefore, base his tender having due regard to all the conditions prevailing at the time of tendering. It can, of course, be argued that it is open to a tenderer to amend or withdraw his tender before acceptance when altered conditions seem to dictate such a course, and if he fails to exercise his rights he must suffer for his failure. But if, in a Court of Equity, he pleads oversight in this respect, urging that, in the absence of any intimation concerning the acceptance of his tender within a reasonable time—say six months—he had regarded it as having lapsed, and if, in addition, he can produce evidence to show that his tender took into consideration conditions which had materially altered before it was accepted, he might contend with some effect that it was obtained by the other party at that particular time to secure definite advantages which, in the altered circumstances, could only be obtained at his expense. In any case, whatever the strict rights and responsibilities of the parties, the reasonable and wise course in such circumstances is to afford all-tenderers an opportunity of reviewing their quotations.

The determination of the most favourable tender will not, as a rule, present any serious difficulty. Where the samples and drawings submitted by the lowest tenderer meet all the requirements of the specifications the matter is clear, provided that satisfactory prices are quoted for additional work which may be required, but which, if

required, will be paid for separately. Where, as frequently happens in contracts involving the provision of power plant, the tenderers offer to supply plant of different types, which, to achieve the results required by the specification, demand the consumption of different amounts of energy, the basis of comparison will be not the original capital outlay represented by the amount quoted by the respective tenderers, but the annual expenses involved in the adoption of the various types of plant they offer. To determine the lowest tender in such cases all the different factors which together make up the annual cost, will be taken into account. Generally speaking, these include: (1) Interest on capital, (2) cost of power, and (3) cost of renewal. Other differences may have to be considered. There may be a known difference in the cost of ordinary maintenance and repairs, and in calculating the annual cost of renewal, *i.e.* the amount to be set aside each year to replace the original capital outlay, different periods may have to be taken as representing the probable "life" of the various types of plant.

Before finally accepting any tender the party to whom the offer is made should satisfy himself that the tenderer makes no modifications or stipulations which are not consistent with the requirements and conditions set forth in the plans and specifications, unless they are of a trivial character and have no material effect on the result which the contract seeks to achieve. The terms of the offer should be as definite and clear as the terms of the specification, and any failure in this respect should be remedied before acceptance is signified. Two examples will probably serve to illustrate the point. A tenderer may offer to complete the work in a certain time "if sufficient labour is available" or "if weather favourable." One frequently needs considerable powers of imagination in the interpretation of contracts, but it is quite conceivable that two or twenty persons might differently and yet reasonably interpret either of these stipulations, the acceptance of which might lead to considerable friction and appreciable loss or inconvenience, for which there might be no enforceable remedy.

The execution of a contract which has been based upon plans and specifications well conceived and carefully prepared, in which are clearly expressed the intention of the party for whom the work is to be undertaken, is not likely to be seriously hindered by disputes. Friction does occasionally arise between the representatives of the two parties, but one is inclined to think that it could be largely avoided by a more generous exercise of the spirit of compromise in matters which do not seriously affect the object of the contract. Insistence on the strictest adherence to the letter of the agreement in all details might not prove in all circumstances to be advantageous to either party.

A supervising engineer should make himself thoroughly familiar not only with all the engineering requirements of the contract, but with the general conditions governing the relations between the parties. The prompt payment of accounts, for example, is just as much an obligation of the contract, and failure or delay in this respect just as much a breach of the contract, as failure or delay on the part of the contractor in giving effect to any purely engineering requirement. He should, moreover, study carefully the nature and extent of his powers as defined in, or as may fairly be implied from, the terms of the contract. He cannot go beyond or behind the contract. He is rarely vested with absolute powers of direction and control, as where these are bestowed upon him the contractor is relieved of all responsibility, ceases to be an independent contractor, and becomes merely a servant. His functions are chiefly supervisory, and, as a rule, he will be thankful that they are limited to this extent. He has to see that the quality and character of the work reach the standard demanded in the contract, that no defective work is hidden, that no work outside the contract is performed without his written instruction or approval, that, fulfilling all the contract obligations of the party he represents, he places no obstacle in the way of the contractor which the latter might use as an argument to secure release from his own obligations. He must not, moreover, by his silence, appear to signify his acquiescence in any departure from the contract requirements and conditions lest his conduct be held to have waived or modified the same; and, above all, he must, so far as he is empowered to interpret the contract, aim at the most reasonable construction where differences of interpretation have arisen. For, after all, in the long run it pays in contract dealings to be reasonable. It pays the contractor. If he is always on the look-out to take advantage of a literal interpretation of the contract or of an obvious mistake in the specification, and, if rejecting offered compromise, he successfully carries his case through the Law Courts—and this is a very big “if”—his fame is spread abroad to his manifest disadvantage. And it pays the other party. If, in his turn, he adopts a like attitude towards the obvious mistakes of the contractor, insists that the specification everywhere and always means just what it says and is upheld by the legal powers—and here again it is extremely improbable that he will be—his success will be dearly purchased. The markets will go up against him very quickly, and he will find how costly it is to enforce rights under provisions which were regarded by the other party as being of a protective rather than a penal character, as safeguarding against loss actually sustained rather than as penalising the contractor in circumstances involving no loss, or to an extent out of all proportion to any such loss. It is sometimes good policy, as well as good morals, to waive rights.



EDITORIAL NOTES AND COMMENTS.

ONE result of the formation of the Coalition Cabinet affects our Department closely. The Right Honourable Herbert Samuel has returned to his former office of Postmaster-General. It is not possible for anyone outside the inner parliamentary circle to say with confidence that, from a purely political point of view, he is to be congratulated, but it is at least certain that all branches of the Department will warmly welcome their new chief. During his previous term of office here Mr. Samuel acquired a sound grip of the administrative details of the entire service, and many times he betrayed a knowledge of the technical side that surprised the experts. Confronted by the difficulties occasioned by the transfer of the late National Telephone Company's plant and staff to the State's ownership and control, difficulties that were increased by an active anti-State telephone campaign in the press, the Postmaster-General met the situation with energy and consummate tact, and while he did not achieve the impossible by silencing all complaints from both public and staff, he satisfied the commercial world that the Post Office was able and willing to provide a satisfactory telephone service, and almost persuaded the staff that both pre-transfer and transferred officials were better off than they were before 1912. Automatic telephony was introduced into this country during the previous *régime* of Mr. Samuel, and we are sure he will be keenly interested in the developments that have taken place in his absence.

We take this opportunity of bidding farewell to Mr. Hobhouse, who, in obedience to the stern vicissitudes of the time, has given

place to Mr. Samuel. The ex-Postmaster-General had held office for but a brief time prior to the outbreak of war—he was appointed on February 12th, 1914—and had therefore only some five months' opportunity of getting into touch with the organisation before the appeal to arms dimmed the vista of progress opening up before the Engineering Department. As is known, however, he had interested himself closely for some years in post office staff matters, and he acted as Chairman of the Select Parliamentary Committee of 1906-7 which inquired into the pay and conditions of service of post office employees. Much good work, however, has been accomplished during his *régime*, and had the fates been kinder we are confident he would have left the Department with a long record highly creditable to himself and to the engineering staff under his control. We have much pleasure in publishing the following extract from a letter received by Sir William Slingo, dated June 6th, from Mr. Hobhouse :

“My connection with the Department is now severed, but I should like to take this opportunity of thanking you personally, and all your engineering colleagues, for the advice and assistance so freely afforded to me while I was P.M.G.

“Yours very truly,
“C. HOBHOUSE.”

We observe, from the ‘Western Union News,’ that the Company has begun the installation of its multiplex printing telegraph system on twenty-five important circuits connecting the cities of the Atlantic seaboard with each other and with those of the middle west. For the past eighteen months the system has been operated between New York and Boston, and during that period, it is claimed, the circuit has carried a greater volume of traffic than any commercial telegraph circuit in the world. The principle is somewhat similar to that of the Baudot quadruple duplex, with the addition of a type-writer keyboard, on which the slip for transmission is prepared and the further modification that the received message is printed in page form. Between New York and Boston the circuit has been operated for the last six months at a speed of forty-five words per minute both ways on each of the four channels, giving a total duplex speed of 180 words per minute. The sets purchased by the British Post Office are working on a London-Manchester circuit, and a speed of forty words per minute per channel is being satisfactorily maintained. We hope to be able to give our readers a complete technical description of the system before the present volume is completed. War pressure must be pleaded as our excuse for not dealing earlier with this promising development.

In spite of the advance of machine printing telegraphs, the war has demonstrated the value to the State of the capable Morse operator. The demands of the Signal Companies, Royal Engineers, and the special privileges attached to that corps, plus the laudable desire to "do their bit," have induced many purely telephone men who were formerly inclined to fight shy of the telegraphs; deeming that branch a poor Cinderella whose bloom had long departed, to turn their attention to the Morse code and its many practical applications. Judging from the present zeal, the Department may reckon upon a considerable increase in the number of engineering officers capable of reading by sound.

Much satisfaction is being expressed throughout the service at the honour conferred upon Mr. Stewart, Glasgow, whose name appeared in the last Birthday List as having received the Imperial Service Order. "D. S." has passed many budding engineers through his hands, and we are confident there is not one among them but feels that if ever civil servant deserved the Order it is the S. E. of Scotland West.

As promised in our last issue, we give below the list of engineering officers who have received commissions in His Majesty's forces.

LIST OF OFFICERS OF THE ENGINEERING DEPARTMENT HOLDING
COMMISSIONS IN THE ARMY OR NAVY.

E.-IN-C.'s OFFICE.

Name.	Military or Naval Rank.	Corps.
Booth, A. C.	Major (Assistant Director, Home Signals)	Royal Engineers Sig. Sect.
Brown, H.	Captain	" "
Lee, A. G.	2nd Lieut.	" "
Mountain, W. S.	"	" "
Cottle, P. J.	"	London Air Line Sig. Co. R.E.
Mallet, E.	Lieut.	Lowland Div. Sig. Co. R.E.
Turner, F. G.	Captain	" "
Frost, P. B.	2nd Lieut.	Lond. Sig. Sce. Trg. Centre R.E.
Lockhart, J.	Captain	Royal Engineers Sig. Serv.
Picker, H. F.	2nd Lieut.	Scottish Air Line Sig. Co. R.E.
Reid, F.	"	" "
Carter, H.	"	" "
Legg, J.	"	Southern Cable Sig. Co. R.E.
Smith, N. S.	,	4th Battn. Essex Regt.

EDITORIAL

NOTES AND COMMENTS.

Name.	Military or Naval Rank.	Corps.
E.-IN-C.'S OFFICE— <i>continued</i> .		
Dunsheath, P. .	2nd Lieut.	Royal Engineers Sig. Serv.
Newlands, T. H.	"	" "
Gold, R. J. S.	Captain	15th Battn. County of London.
Thomas, F.	2nd Lieut.	Royal Engineers Sig. Serv.
Young, A. M.	"	7th Battn. Essex Regt.
Merrick, W. I.	"	Royal Engineers Sig. Serv.
Turner, P. W.	"	Royal Engineers Sig. Sect.
Lilburn, G. L.	"	" "
Scoones, H. E.	"	8th Sec. Battn. Wilts. Regt.

TESTING BRANCH.

Barnard, E. A.	Lieut.	8th East Lancs. Regt.
Luffingham, L. J.	2nd Lieut.	13th Middlesex Regt.

LONDON DISTRICT.

Lancaster, T. S.	2nd Lieut.	Royal Engineers.
Macrae, D. L.	"	14th County of London (Lond. Scottish).
Cree, J. C.	"	Royal Engineers, Sig. Co.
Low, P. D.	"	3rd Battn. Connaught Rangers.
Sander, R. H.	"	12th Battn. West Yorks Regt.

MET. POWER DISTRICT.

Kingston, J. R.	Lieut.	Royal Engineers Sig. Sect.
Carter, W. G.	2nd Lieut.	" "
Lawson, C. G.	Lieut.	R.N.V.R.

NORTHERN DISTRICT.

Batchelor, W. M.	Captain	Royal Engineers Sig. Sect.
Ward, W. G.	"	Tyne Elec. Engineers.
Vernon, F. L.	"	Northumberland Fusiliers (3rd Tyneside Irish Battalion).
Pollock, C. E.	2nd Lieut.	Royal Engineers Sig. Sect.
McLaughlin, A.	"	" "
Oliver, R. D.	Captain	Northumberland Fusiliers (4th Tyneside Irish Battalion).

NORTH-EASTERN DISTRICT.

Wolstenholme, C. S.	Captain	Durham Light Infantry.
Swift, J. E.	2nd Lieut.	Royal Engineers.

SOUTH LANCASHIRE DISTRICT.

Powell, F. W.	Captain	3rd South Lancashire Regt.
---------------	---------	----------------------------

Name.	Military or Naval Rank.	Corps.
NORTH MIDLAND DISTRICT.		
Timmis, A. C. . . .	2nd Lieut. . .	Royal Engineers.
Evans, A.	Captain . . .	" "
Cooke, J. G. . . .	2nd Lieut. . .	Notts and Derby Regt.
Doig, P.	"	West Lancs. Div. Sig. Co. R.E.
SOUTH MIDLAND DISTRICT.		
Comport, C. H. . .	Captain . . .	Royal Engineers Sig. Serv.
Gwilliam, W. J. . .	Lieut.	" "
Harris, E. C. . . .	2nd Lieut. . .	" "
Linsell, F. A. . . .	"	" "
NORTH WALES DISTRICT.		
Horner, F. H. . . .	2nd Lieut. . .	Royal Engineers.
Cave-Brown-Cave, N. F.	"	" "
Lewis, E. A.	Major	2nd N. Mid. Div. Sig. Co. R.E.
SOUTH WALES DISTRICT.		
McKenzie, J. . . .	Lieut.	1st Monmouthshire Regiment.
Cranage, H.	"	Welsh Division R.E.
Davies, E. I. S. . .	2nd Lieut. . .	Welsh Army Corps, R.E.
SOUTH-WESTERN DISTRICT.		
Bannister, G. W. . .	2nd Lieut. . .	Southern Sig. Co. R.E.
Baker, W. F.	"	11th Service Battn. Glos. Regt.
Snelling, A. A. . . .	Lieut. Qr.-Mr. .	Royal Engineers.
SOUTH-EASTERN DISTRICT.		
Hannam-Clark, H. C.	2nd Lieut. . .	Southern Army Corps Sig. Co. R.E.
Winton, T.	Lieut. & Qr.-Mr. .	8th Royal Dublin Fus.
Turkington, W. H. . .	Lieut.	Army Service Corps.
SCOTLAND EAST DISTRICT.		
Cresswell, H. B. . .	Captain	Lond. Dist. Sig. Co. (London Army Troops) R.E.
SCOTLAND WEST DISTRICT.		
Angwin, A. S.	Major	Lowland Div. Sig. Co. R.E.
Struthers, G. A. . .	2nd Lieut. . .	Royal Engineers.
IRELAND DISTRICT.		
Evans, W. M.	Captain	" L " Sig. Co. R.E.

The total list of officers withdrawn for active service from the Engineering Department up till May 25th is as follows :

Engineering officers	34
Chief inspectors, etc.	21
Senior inspectors, etc.	21
Inspectors	36
Clerical officers	466
Skilled workmen (established)	753
Skilled workmen (unestablished, labourers, youths, etc.)	4102
Other grades	127
	5560

In addition to the above there are 103 Royal Engineers withdrawn from Ireland.

OBITUARY.

AUGUSTUS STROH.

ON November 2nd, 1914, passed away, at the ripe age of 86, a great pioneer in the telegraphic world. Comparatively little known by members of the present generation, Augustus Stroh was a most charming personality, and was most sincerely respected, not to say loved, by those who had the honour to be acquainted with him. A German by birth, having been born in Frankfort in 1828, he came to England on a holiday at the time of the Great Exhibition of 1851, and was so impressed by our free institutions that he settled here, becoming a naturalised Briton in 1869. Soon after he arrived in this country he became closely associated with the late Sir Charles Wheatstone, as mechanic and assistant, and it is not too much to say that the beautiful and practical inventions devised by Wheatstone very largely owed their success to the mechanical genius of Stroh. The late Sir William Preece, who was a personal friend of and had a great admiration for Stroh, spoke of him as the "prince of mechanicians," and those who knew Stroh's wonderful fertility in the field of mechanism could not but admit that the title was well deserved. Much of the work done by Stroh, and the ingenious mechanical devices devised by him, are unfortunately but little known, but some slight insight into them may be gathered from the few patents which he took out. Two pieces of telegraph apparatus, however, namely, the "A. B. C." and the "Automatic," which are indissolubly connected with the name of Wheatstone, largely owed their success to the mechanical skill of Stroh, and a study of the ingenious devices used in these instruments fills a lover of

mechanism with keen admiration. For his work in connection with the Wheatstone Automatic high-speed apparatus he was awarded a Gold Medal by the International Jury of the Paris Exhibition of 1878. To enumerate the numerous inventions and contrivances devised by Stroh would occupy many pages, but, amongst others, his system of magneto-electric clocks, patented many years ago, deserves mention for great ingenuity. His violin, in which there is no body, the vibrations being transmitted to a diaphragm provided with a trumpet, was remarkable for the volume of sound which it gave out and for the closeness to which it approximated to the true violin tone. Following on the remarkable experiments and researches of Bjerknes with vibrating bodies in a water medium, Stroh gave a striking demonstration of his ingenuity and manipulative skill, in a paper read before the Institution of Electrical Engineers in 1882, on "Attraction and Repulsion due to Sonorous Vibrations, and a Comparison of the Phenomena with those of Magnetism"; the apparatus (manufactured by the author himself) used on this occasion was noticeable for its high finish. For some years Stroh carried on a factory (in the Hampstead Road) in which apparatus was manufactured for the Post Office; on his retirement from active business in 1880, this factory was taken over by the Department and formed the nucleus of the "Holloway Factory," the products of which are so well known to all telegraph men.

As is the case with many other really great men, the name of Augustus Stroh is almost unknown to the public, but the work that he did was of high importance, and its valuable results are still with us.

H. R. K.

Mr. Stroh was a Member of Council of the Institution of Electrical Engineers for the years 1880-89 and 1894-96, Honorary Auditor 1890-97, and Honorary Auditor of the Benevolent Fund 1890-99. He bequeathed a sum of £500 in payment of legacies of £250 each to the Building and Benevolent Funds of the Institution.

HEADQUARTERS NOTES.

TELEGRAPHS.

THE extension of printing telegraphs continues. The Liverpool Quadruple Duplex Baudot has been converted to a Quintuple Duplex. A second Quadruple Duplex Baudot circuit has been established between London and Glasgow, and a second Quadruple

Duplex will shortly be working between London and Liverpool. A Quadruple Duplex Baudot will, by the time these lines appear in print, be established between London and Brighton.

Considerable extensions of the Wheatstone Creed system have recently been made. This apparatus is now installed at London, Birmingham, Manchester, Liverpool, Glasgow, Aberdeen, Southampton, Edinburgh, Bristol, Plymouth, Peterhead, Dublin, Grimsby, and Leeds.

At Warrington there are now four Duplex Repeaters installed. Two of them are employed on the London-Glasgow Baudot circuit, one on the London-Glasgow Wheatstone Creed circuit, and one on the London-Newcastle Wheatstone Creed circuit.

Kleinschmidt Perforator.—A new form of keyboard perforator has lately been introduced, and has given promising results. For each depression of a key the corresponding Morse letter is perforated on the Wheatstone slip. In this respect it is like the Gell Keyboard Perforator, but the actions which obtain this result are on different lines.

MANUAL EXCHANGE DEVELOPMENTS.

Orders have been placed for the equipment of new C.B. Exchanges at—

Huddersfield	2460 lines
Wishaw	240 „

Orders have been placed for extending the existing equipment at—

Belfast 10 positions rearranged for trunk and junction working.

East (London)	280 lines
Finchley	700 „
Greenock	400 „
Lee Green	200 „
Salisbury	160 „

Installation has been commenced at—

Belfast conversion from single to double clear.

Brixton Extension	1500 lines
Sale „	120 „
Willesden „	540 „

Installation of the following equipment has been completed :

Birmingham Central Extension	4600 lines
Sheffield Extension	600 „
Walthamstow Extension	320 „

In addition to the above, minor extensions and modifications have been made to a large number of existing exchanges throughout the country.

The following new exchanges have been opened :

Exchange.	Date of opening.	Number of subscribers' lines.	
		Exchange equipped for.	At date of opening.
Greenwich .	February 27th, 1915	1500	431
Weybridge .	March 20th, 1915	600	488
Romford .	May 15th, 1915	360	237
Lowestoft .	May 27th, 1915	480	—

INSULATING COMPOUNDS.

For some considerable time efforts were made to discover some compound which would do away with the inconvenience and danger of using a heated pot in such places as the top of a pole or ladder.

The compound formerly used for filling in the tops of terminal and leading-in insulators was solid at ordinary temperature, and required to be heated to melt it for pouring in. Great difficulty was experienced in evolving a compound which would combine the following qualities :

(1) Soft enough to be easily and conveniently pressed cold into the insulator top.

(2) Not materially affected in consistency by changes of temperature likely to be met in practice.

(3) High insulation resistance dry, and maintained when in contact with water.

Many mixtures were tried and found wanting before a reliable one was secured.

A mixture of coal-tar and whiting having been found very successful in sealing the joints of stoneware ducts, it was thought that a compound of this nature might possibly be used in the above connection.

Two compounds were accordingly made up of—

(a) Coal-tar and whiting.

(b) Coal-tar and French chalk.

In spite of careful drying of the whiting, mixture (a) proved useless both on account of low insulation resistance dry and a progressive drop in resistance when immersed in water. As whiting (calcium carbonate) is a comparatively soluble salt, this is not surprising. Compound (b), however, gave a high insulation resistance and no progressive drop in resistance on immersion, French chalk (magnesium silicate) being practically insoluble in water. The French chalk was carefully dried by heat, and mixtures of several consistencies made up and experimented on in insulators wired up as in general use.

The best mixture was of about the consistency of marzipan at ordinary temperature, and this varied only slightly up to 150° F.

This compound was of a somewhat dry and inelastic nature, and a small addition of palm pitch was suggested to make it more plastic. This turned out an improvement on trial both in consistency and insulation resistance, provided not too much pitch was added, as the mixture would then become too hard at an ordinary temperature but too fluid at about 100° F.

The compound was also frozen in a mixture of ice and salt at a temperature in the proximity of 0° F. It became harder, but by no means brittle or liable to crack.

The most satisfactory mixture was made up as follows :

56 per cent.	French chalk	} by weight.
32 ,,	palm pitch	
12 ,,	coal tar	

And the insulation resistance figures in the case of an ordinary insulator wired up were as follows :

Dry	Infinity
Immediately on immersion in water	„

With no drop after prolonged immersion.

This compound is much cheaper than the solid compound, No. 2 (4d. per lb.), working out at about 1d. per lb.

It is also of simpler composition, having three instead of five constituents, and is, on the whole, expected to prove a considerable advance on previous practice.

The compound is to be thoroughly pressed into the cavities of the insulators so as to enclose completely the bare wire joints, care being taken to see that the cavities are quite dry before it is put in.

This plastic compound is known for stock purposes as "Compound No. 5," and is now used also for sealing the joints in subscribers' premises between the leading-in paper core cables and the "Cable enamelled and flame-proof" used as house leads. "Terminal blocks," Nos. 1, 2 and 3, are used respectively for 1-pair, 2-pair and 4-pair cables, and are filled with compound after the connections are made.

A modification of the above compound ("Compound No. 6") has been adopted for sealing Sykes' ducts. In this case the proportions are 47 parts by weight of French chalk, 47 of coal-tar, and 9 of palm pitch.

LONDON DISTRICT NOTES.

NEW BUILDINGS IN PROGRESS.

London District Headquarters, Denman Street, London Bridge.—The work has been steadily continued on this building during the

past quarter, and it has now reached its full height. A proposal to provide a rifle range in the sub-basement is under consideration.

Four New Exchanges for the City.—Four new 10,000-line exchanges, located within a comparatively small area, are in the initial stages, namely: Charterhouse, Holborn, Bishopsgate, and Tower.

At *Charterhouse* (near the "Angel") the building is being erected.

The new *Holborn* Exchange will occupy the building, near Lincoln's Inn Fields, known as the "Inns of Court Hotel." Work will shortly be commenced there.

The *Bishopsgate* Exchange will occupy a site near the once notorious Middlesex Street, not far from the Mint in one direction and the Aldgate Pump City boundary on the other side.

The *Tower* Exchange will be situated in Eastcheap, near the north end of London Bridge, and under the shadow of the Monument which was erected to commemorate the Great Fire of London. The old building which occupied this site has already been demolished.

EXCHANGE EXTENSIONS.

Paddington.—The installation of the experimental 1000-line automatic traffic distributor has been completed, but it has not yet been brought into use. Twenty-four incoming junction positions are in process of conversion from machine ringing to keyless ringing. Eleven have already been completed. Three "A" positions have been converted to jack-ended junctions.

Hammersmith, Chiswick, and Willesden.—The extensions reported in the last issue as having been commenced, namely:

Hammersmith, 1120 lines and 258 junctions;

Willesden, 700 lines; and

Chiswick, 1120 lines and 140 junctions;

are nearing completion.

Wimbledon.—An extension of the Central Battery No. 1 Ancillary type switchboard at Wimbledon has been completed by the Automatic Telephone Manufacturing Company, bringing the multiple equipment at this exchange up to 3200 subscribers' lines.

Streatham.—An extension of the Central Battery No. 1 switchboard at Streatham has been completed by the Western Electric Company, bringing the multiple equipment at this exchange up to 2800 subscribers' lines.

EXCHANGE MAINTENANCE.

Vacuum Cleaners.—All the exchanges in the London engineering district have now been equipped with vacuum cleaners.

NEW PRIVATE BRANCH EXCHANGES.

Regent Palace Hotel, Piccadilly Circus.—This important addition to London's palatial hotels was opened to the public on May 26th. It has been wired throughout for telephone service.

The wiring provides for a maximum of 400 extensions from the Private Branch Exchange, which is on the Mezzanine floor. From the Private Branch Exchange separate cables are taken through a false ceiling over the dining and grill rooms to five vertical chases. A distribution case is fitted in each vertical chase on every floor, and from the distribution cases wires can be run to any required point. In places where the cables would be exposed the hotel authorities have fitted oak casing to harmonise with the general decorative surroundings. A large number of call offices are fitted in various parts of the building, and these have been constructed by the hotel authorities in oak or mahogany according to the decoration of the rooms in which they are fitted. Fourteen of these call offices are in the Private Branch Exchange room, and these are controlled through intercepting keys by a special attendant, so that the switchboard operator is relieved of the work of dealing with the call office traffic. The switchboard is a 2-position board, C.B. multiple No. 9, and is equipped for 30 exchange lines and 100 extensions. The total capacity is 40 exchange lines and 400 extensions.

It is desired to draw attention to the cordial co-operation and assistance which was rendered throughout to the Department by the Architects and the Clerk of Works, and it is pleasant to record that they have expressed entire satisfaction with the manner in which the work was carried out.

King George's Hospital.—During the month of May the building which was erected in Stamford Street, S.E., for use as H.M. Stationery Office, has been opened as a military hospital under the title of King George's Hospital. It is a magnificent building with some acres of floor space, which have now been subdivided into wards, kitchens, operating theatres, X-ray rooms and the many other departments necessary in a hospital designed for the accommodation of more than 1,500 wounded soldiers. Telephones have been fitted throughout by the Post Office Engineering Department, and they are connected to a 2-position multiple branch exchange. The switch room, which is conveniently arranged for extension, is situated on the fourth floor, and the operating is done by female operators supplied by the Post Office.

Co-operative Wholesale Society.—Two 100-line boards have been fitted at Leman Street premises of this Society, to provide for additional telephone extensions. At present 18 exchange lines and 94 extensions are working.

New Telephone Lines.—During the thirteen weeks ended April 27th, 3,425 exchange lines, 2,793 internal extensions, 269 external extensions were fitted. In the same period 3,370 exchange lines, 1,791 internal extensions, 242 external extensions were recovered, making a net increase of 55 exchange lines, 1,002 internal extensions, 27 external extensions.

EXTERNAL CONSTRUCTION.

For the three months ended April 30th, 1915, the net increase in telephone exchange single wire mileage of the London Engineering District was 18,956 miles, the increase under the head of underground being 19,669 miles, whilst the open (bare wire) and open (aërial cable) decreased by 136 and 577 miles respectively.

Trunk wire mileage increased by 992 miles, but telegraphs show a decrease, which is mainly due to readjustments.

Pole line mileage was unaffected during the quarter, but pipe line increased by eighty miles.

The aggregate mileage at the end of April, 1915, under the various services were as follows :

<i>Line.</i>	<i>Miles.</i>	
Pole line (bare wire)	2,467	
Pipe line	3,406	
<i>Single wire.</i>		
Telegraphs	21,460	} inclusive of spares, exclusive of wires on railways maintained by companies.
Telephone Exchange	958,390	
„ Trunk	30,237	

The total length of cables is now 6,987 miles.

It will be observed that the grand total now exceeds ONE MILLION MILES.

It will be noted that the economic process referred to in our last issue, namely, the giving up of single telephone lines by small firms and the acquisition of additional extensions by large firms, continues.

NORTH-WEST EXTERNAL SECTION.

Opening of Rifle Range.—The North-West External Section—presided over by Mr. E. J. Wood—which has long occupied an enviable position in the maintenance records, has given additional evidence of its vitality by the provision near the headquarters at Willesden of a rifle range. The ceremony in connection with the opening of the range was performed by Mr. Moir on the evening of March 31st.

Patriotic speeches were delivered by Mr. Moir and Mr. Kennedy.

Mr. White, the Hon. Secretary, to whose hard work the success of the Club is largely due, proposed a vote of thanks to Mr. Moir, who suitably responded.

The Range was then formally opened by Mr. Moir firing the first shot, and obtaining a "bull," which should prove an augury of success to the Club.

The Committee would like to take this opportunity of stating how pleased they would be to receive fresh members from any Post Office officials resident in the neighbourhood of Willesden, and to afford shooting facilities to any others who may be in the neighbourhood at any time. The Range is open from 6 to 8 p.m. every evening.

War Service.—Up to the end of May, 1915, 1,021 workmen out of a total of 4,634, 22 per cent., and 125 clerks out of a staff of 443, 28 per cent., have joined the colours. This makes 1,146 on active service out of a staff of 5,077, or 23 per cent. Six officers of the District have been given commissions—one captain and five second lieutenants.

LOCAL CENTRE NOTES.

LONDON CENTRE.

THE Session came to a close with the Annual General Meeting held on April 19th, at which the Engineer-in-chief presided and presented the Institution medals.

After the usual business, Mr. H. H. Harrison (formerly of the C.T.O.) read a most interesting paper on the "Historical Basis of Modern Printing Telegraphy." The Director of Army Signals (Home Defence), Col. Ogilvie, and Messrs. Murray, Creed, and Gell, amongst others, were present and took part in the discussion.

The war has somewhat affected the attendance at meetings, and it was also thought desirable not to attempt to arrange any visits.

The Committee have much pleasure in acknowledging a gift of 'Royal Engineer' journals by Sir John Gavey. These have been placed in the Central Library.

They also invite offers of papers for the forthcoming session. They venture to express a hope that all available members will co-operate in successfully carrying on the work of the Institution.

Messrs. A. Watts and R. Waring succeed Mr. Purves and Mr. Greenham as Chairman and Vice-Chairman respectively.

W. G. O.

SCOTLAND WEST CENTRE.

The second meeting of the session was held on March 1st, when a paper was read by Mr. J. K. Murray on "Some Aspects of Maintenance."

The lecturer first dealt with the question of roof repairs and wayleaves. It was suggested that all wayleave officers should be associated in the same office along with the inspector dealing with roof repairs, in order that duplication of visits to factors might be avoided and to ensure that important information might be in the hands of all officers seeing factors. [A "factor" in Scotland is the representative of the land or house property owner responsible for the letting and maintenance of the property.—ED. JOURNAL.]

Mr. Murray then went on to discuss the general question of line and exchange maintenance, and special attention was drawn to the question of potheads and terminal boxes. It was stated that there were over 1000 Western Electric terminal boxes in Glasgow, and it was suggested that their use should be extended owing to their efficiency and convenience for maintenance purposes.

The following record was given of D.P.s where Western Electric terminals had been in use for five years :

No. of D.P.s 18. No. of Subscribers 144.

Number of subscribers with no faults for 5 years, 106, or 73·6 per cent.

Number of subscribers with 1 fault for 5 years, 26, or 18·0 per cent.

Number of subscribers with 2 faults for 5 years, 6, or 4·2 per cent.

Number of subscribers with 3 faults for 5 years, 5, or 3·5 per cent.

Number of subscribers with 4 faults for 5 years, 1, or ·7 per cent.

Lantern slides were shown of the methods used in terminating cables, and several interesting pictures were also thrown on the screen showing various types of ex-National Telephone plant, including the original standard fixed on the Royal Exchange, Glasgow.

The third and final meeting of the session was held on March 29th.

A paper was read by Mr. J. S. Paterson on "C.B.S. Multiple Scheme."

The lecturer gave a description of the new type of board, which is worked entirely from primary cells, and by means of lantern slides he illustrated the general appearance and wiring of the various circuits. Special attention was drawn to the engaged test, meter circuit, ringing arrangements, and junction clearing.

A short description was also given of the unit auxiliary apparatus, which provides for certain types of junction being already wired and

permits of all the junction wiring being done exactly alike, so that the conversion from one type of junction to another can be done by cross-connecting. Comparative details were also given of the reed-ringer and the new ringing vibrator which is being used.

Brief descriptions of the testing and battery arrangements were also given.

Mr. Paterson has made a special study of the exchange systems, and he was cordially thanked for his illuminating paper.

The following Committee have been elected for next session :

Chairman : Mr. Stewart. Vice-Chairman : Mr. Hardie. Mr. F. D. Horton, Mr. J. K. Murray. Secretary : Mr. G. A. Struthers. Librarian : Mr. H. McCallum.

ROLL OF HONOUR.

WE sincerely regret to announce the deaths of the following men killed in action, who were drawn from our Department for active service. Third List. (A) Army. (A.T.F.) Territorials. (R.M.L.I.) Marines.

Name.	Rank.	District.
L. B. Adams (A) . . .	Assistant Clerk	. London
J. W. Ashley (A) . . .	Labourer	. N. Wa.
F. W. Barlow (A) . . .	Bricklayer	. London
W. Bedford (A) . . .	Labourer	. N.E.
W. Bell (A) . . .	"	. N.
H. Bichener (A) . . .	Unest. Skilled Workman	. S. Mid.
G. H. Chappell (A) . . .	Labourer	. S. Lancs.
J. Clark (A.T.F.) . . .	"	. "
C. Colhoun (A.T.F.) . . .	Unest. Skilled Workman	. London
J. A. Depledge (A) . . .	Youth	. N. Mid.
H. Dobson (A) . . .	Labourer	. N. Wa.
E. Farmer (R.M.L.I.) . . .	Skilled Workman, Cl. II.	. S.E.
E. Fleming (A) . . .	Youth	. N.E.
H. Fricher (A) . . .	Unest. Skilled Workman	. S. Wa.
S. H. Henderson (A.T.F.) . . .	Youth	. S. Lancs.
E. Hollamby (A) . . .	Labourer	. S. E.
J. A. Howes (A) . . .	Skilled Workman, Cl. II.	. E.
H. Hudspeth (A) . . .	Labourer	. N.
W. A. James (A) . . .	Unest. Skilled Workman	. S. E.
J. R. Jones (A) . . .	"	. S. Wa.
W. G. E. Keep (A.T.F.) . . .	Skilled Workman, Cl. I.	. Test. Br.
M. Lane (A) . . .	Skilled Workman, Cl. II.	. London

STAFF CHANGES.

STAFF

Name.	Rank.	District.
F. Lawrence (A) . . .	Unest. Skilled Workman	S. Mid.
A. McAffar (A) . . .	" " "	Scot. W.
W. McQueen (A) . . .	" " "	Scot. W.
A. A. Moody (A) . . .	Boy Clerk	E. in C.O.
A. Morris (A.) . . .	Labourer	S. Lancs.
A. Norton (A) . . .	Unest. Skilled Workman	E.
R. C. Pace (A) . . .	" " "	London
A. Redfern (A) . . .	Labourer	N. Mid.
G. Riley (A) . . .	Youth	S. Lancs.
A. Smith (A) . . .	Labourer	N.E.
A. B. Smith (A) . . .	"	N.
A. M. Taylor (N) . . .	Unest. Skilled Workman	Scot. E.
W. J. Taylor (A) . . .	Labourer	S. Wa.
H. E. Waite (A) . . .	Youth	N.W.
H. Walker (A) . . .	Unest. Skilled Workman	Scot. W.
J. Watson (A) . . .	" " "	N.
H. W. Webb (A) . . .	Labourer	S. Mid.

STAFF CHANGES.

POST OFFICE ENGINEERING DEPARTMENT.

PROMOTIONS.

Name.	From.	To.	Date.
Gomersall, E. . . .	Asst. Suptg. Engr., S. Mid.	Suptg. Engr., Ireland	23 : 4 : 15
Evans, T. . . .	Engr., 2nd Cl., Scot. W.	Asst. Engr., N. Wales	6 : 4 : 15
Ray, J. W. . . .	Chief Insp., N.W.	Asst. Engr., Ireland	22 : 4 : 15
Devereux, T. . . .	Engr., 2nd Cl., E. in C.O.	Asst. Engr., E. in C.O.	12 : 4 : 15
Bowyer, G. . . .	Engr., 2nd Cl., N.W.	Asst. Engr., Ireland	23 : 4 : 15
Phillips, F. J. . . .	Chief Insp., London	Asst. Engr., London	12 : 4 : 15
Watson-Weatherburn, S. W.	Chief Insp., Scot. E.	Asst. Engr., Scot. E.	25 : 5 : 15
Medland, G. F. . . .	Clerk, 3rd Cl., E. in C.O.	Clerk, 2nd Cl., E. in C.O.	18 : 5 : 15
Barlow, J. E. . . .	Clerk, 2nd Cl., E. in C.O.	Postmaster of Gosport	6 : 5 : 15
Waller, J. . . .	Engr., 2nd Cl., E. in C.O.	Asst. Engr., Ireland	To be fixed later
Stanton, J. D. . . .	Engr., 2nd Cl., S.W.	Asst. Engr., E. in C.O.	To be fixed later

NOTICES

EDITORIAL NOTICES.

TRANSFERS.

Name.	Rank.	Transferred from.	To.	Date.
Randall, W. J.	3rd Cl. Clerk	London Dist.	Testing Branch	25 : 5 : 15
Blower A. W.	"	Northern Dist.	N. Mid. Dist.	16 : 5 : 15
Bott, J. T.	"	N. Mid. Dist.	Northern Dist.	16 : 5 : 15
Coxon, J.	Asst. Engr.	E. in C.O.	London Power Dist.	15 : 3 : 15
Johnson, A. S. A.	"	London	E. in C.O.	13 : 4 : 15

RETIREMENT.

Name.	Rank.	District.	Date.
Walton, J.	3rd Class Clerk	Testing Branch	Resigned 30 : 4 : 15

BOARD OF EDITORS.

T. F. PURVES, M.I.E.E., Chairman.
 A. W. MARTIN, A.M.I.E.E.
 Major A. C. BOOTH, R.E.
 J. W. ATKINSON, A.M.I.E.E.
 A. O. GIBBON, A.M.I.E.E.
 W. T. HARRIS.
 W. CRUICKSHANK, A.M.I.E.E., Managing Editor.

COMMUNICATIONS.

All Remittances and Communications should be addressed to the MANAGING EDITOR, P.O.E.E. JOURNAL, Engineer-in-Chief's Office, G.P.O. West, London, E.C.

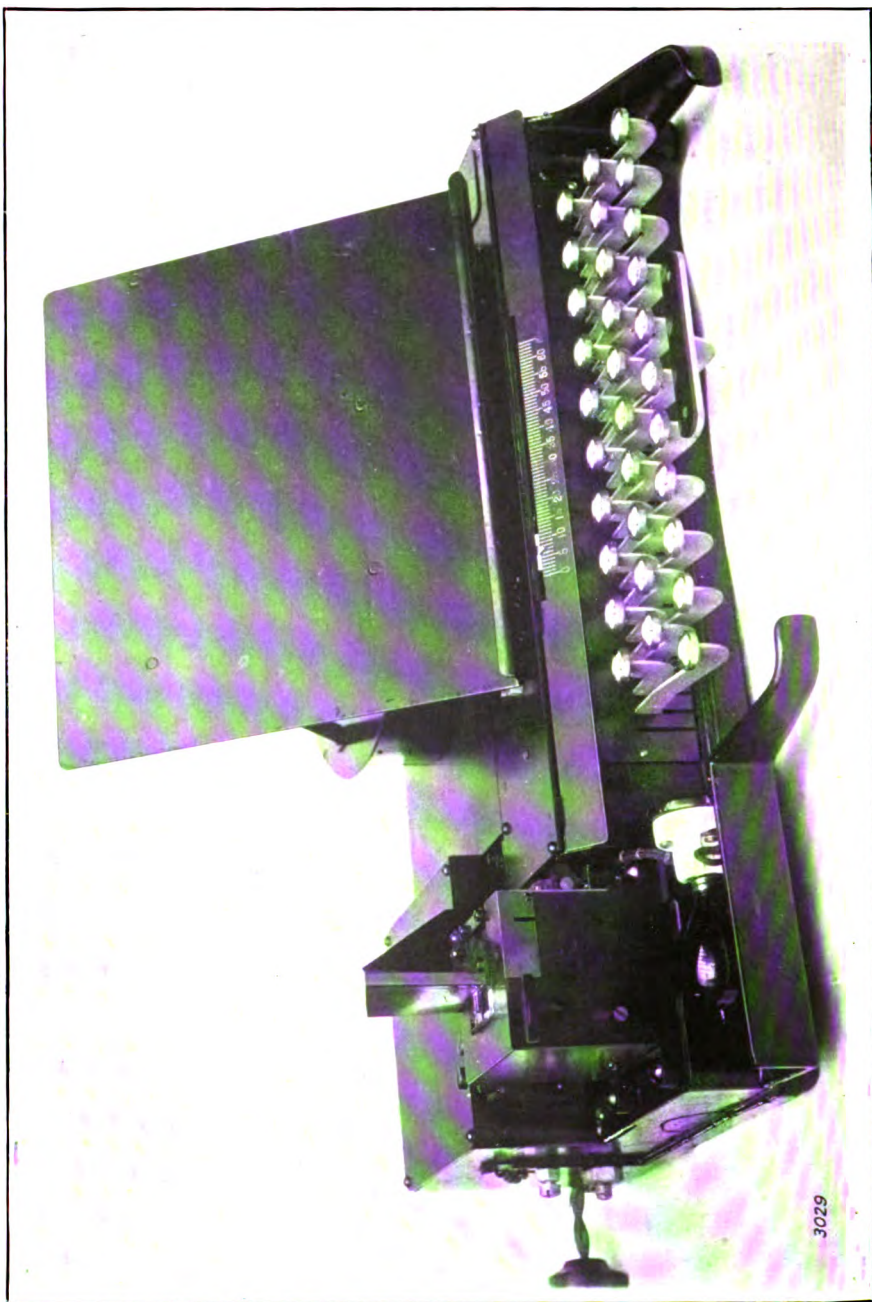
A few copies of Part 1, Vol. 1, and Part 1, vol. 7, of the JOURNAL are required by the Board. Full price will be paid for copies in good condition, or another part can be sent in exchange. The JOURNALS may be sent to the Managing Editor direct, or through the local agents.

Binding covers and copies of the Contents Index for Vol. 7 are now available, and may be obtained from the local agents for 1s. and 2d. respectively. Subscribers can have their copies bound, with index included, at a cost of 1s. 9d., by sending the JOURNALS to the local agents. Orders should indicate whether the original binding covers, or the later pattern, are required.

A supply of the first instalment of the Station List of Engineering Officers eligible for membership of the Institution, issued with the April, 1914, number of the JOURNAL, and including all officers down to Assistant Engineers, is in stock, and copies can be obtained on demand, price 3d. each.

THE NEW YORK
PUBLIC LIBRARY

ASTOR, LENOX AND
TILDEN FOUNDATIONS



5.—KEYBOARD PERFORATOR.



A NEW TYPE-PRINTING MULTIPLEX TELEGRAPH.

THE opinion has been growing amongst telegraph engineers for some time that the most promising line of telegraphic progress lies through the field of type-printing multiplex systems, and this conviction has stimulated many inventors to exercise their talents in the direction of overcoming the mechanical and electrical difficulties incidental to the production of apparatus designed for that purpose.

It would be premature to say that the path of research has been exactly defined, but there is evidence that the ground has been cleared and a substantial foundation laid for future development. The abandonment of the Morse code for multiplex working and the adoption of an alphabet containing the minimum number of units that would allow each signal to occupy the same transmission time has extended the possibilities of multiple channel working. Consequently, the various systems follow, more or less closely, the lead set by Baudot.

The latest form of type-printing telegraph, manufactured and recently introduced to the British Post Office by the Western Electric Company, may be briefly defined as an improved Baudot with automatic transmitters for sending and column printers for receiving.

A five-unit alphabet in which each letter, or other signal, is transmitted by a certain combination of positive and negative currents is employed. Each signal has, therefore, an equal line-time value.

The system is now being worked as a quadruple duplex on an

underground loop circuit in the cable between London and Manchester, a distance of 219·2 miles, the K.R. of the loop, without apparatus, being 37,000. In the preliminary trials, a speed of 51 words per minute was reached on each of the eight channels, making a total of 408 words per minute for the circuit, but for traffic purposes the speed has so far been limited to 40 words per minute for each channel. This speed can be comfortably maintained by the operators and allows an ample working margin.

The apparatus at each office consists of a distributor, four keyboard perforators, four automatic transmitters, four automatic control switches, and four printers. There are also spare instruments for changing purposes, and as all the main connections are made by spring clips the time occupied in changing a faulty piece of apparatus is reduced to a minimum.

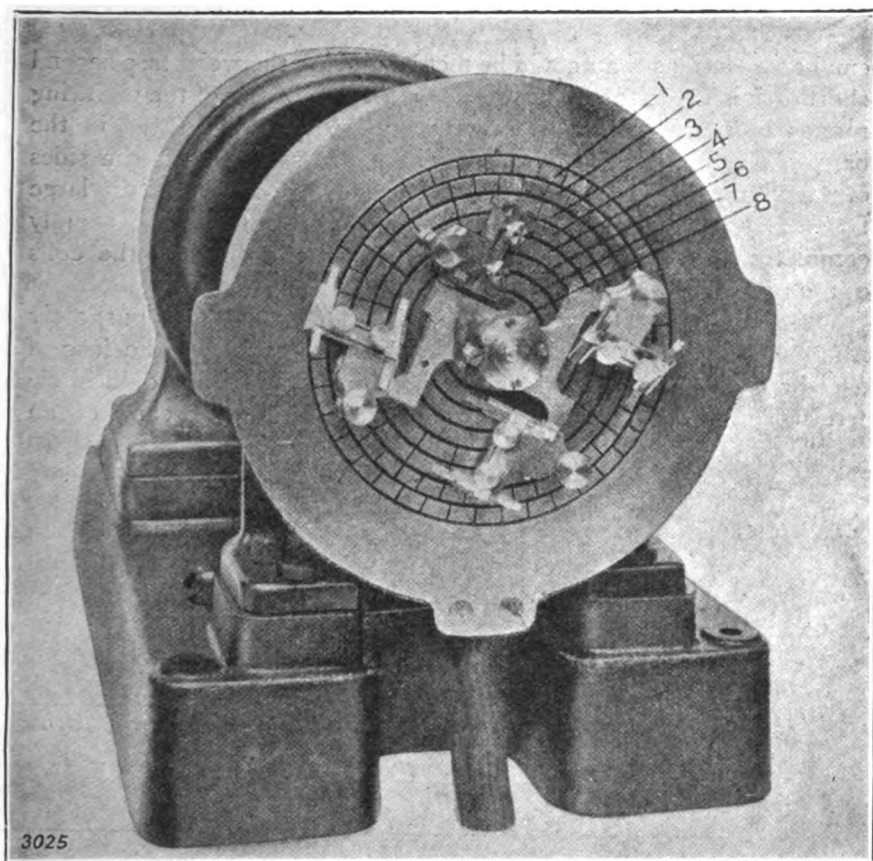
The distributor table accommodates the Post Office standard relays, adjustable condensers, resistance coils, and switches, but fixed resistances, condensers, and the connecting plugs of the distributor are contained in an iron case which is carried underneath the back of the table.

THE DISTRIBUTOR is driven by a phonic wheel motor, and has its face divided into eight rings, the four outer being subdivided into segments, while the inner four are of solid metal. A brush holder, which is clipped to the spindle of the motor, carries four pairs of brushes, each pair forming the connection between one of the solid rings and one of the segmented rings (1).

The outer circle is the receiving ring and consists of forty segments; alternate segments only are utilised for the received signals, the intermediate segments being used to give a flash on a small electric lamp, fixed inside the case of the printer, to indicate to the operator that signals are passing.

The plugs which connect the permanent wiring of the tables to the distributor permit of adjustment within certain limits to allow for line retardation; the receiving ring of the distributor may also be independently moved to refine this adjustment and ensure that the receiving segments are correctly placed. The second ring is for the purpose of correcting the speed of the motor, and is only used at one end of the line.

On the circuit under review, Manchester is the correcting office and London the corrected office. For this reason the Manchester motor is run at a slightly faster rate than the London motor. The speed of the motors is controlled by the action of electrically vibrated tuning-forks (2), the frequency of vibration being regulated by the attachment of weights near the ends of the prongs. Four sets of weights are available, and by referring to a schedule it can at once be decided which set should be used to obtain a given speed. For



Distributor.

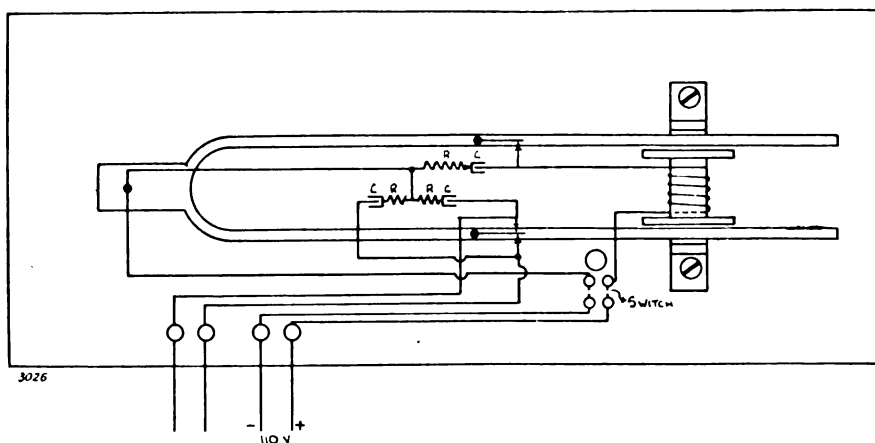
<i>Segmental ring</i>	1		<i>Receiving Brushes</i>
" "	2		<i>Correcting</i> "
" "	3		<i>Sending</i> "
" "	4		
<i>Solid or common</i>	5		<i>Local</i> "
" "	6		
" "	7		
" "	8		

3025 A

TELEGRAPHS TYPE-PRINTING MULTIPLEX TELEGRAPH.

smaller variations than could be met by moving the weights, a second short fork is made to slide up or down the inner sides of the vibrating prongs by a screw action worked by a rotary handle fitted in the base of the instrument. The small fork presses against the sides of the vibrating prongs and governs the effective length of the large fork. By means of spring contacts the vibrating fork rapidly completes and disconnects the electrical circuit through the coils of the motor.

It has already been stated that the London motor is purposely run a shade slower than that at Manchester, but before the loss of speed at the London end reaches the point at which it would interfere with the working, correction takes place by means of an



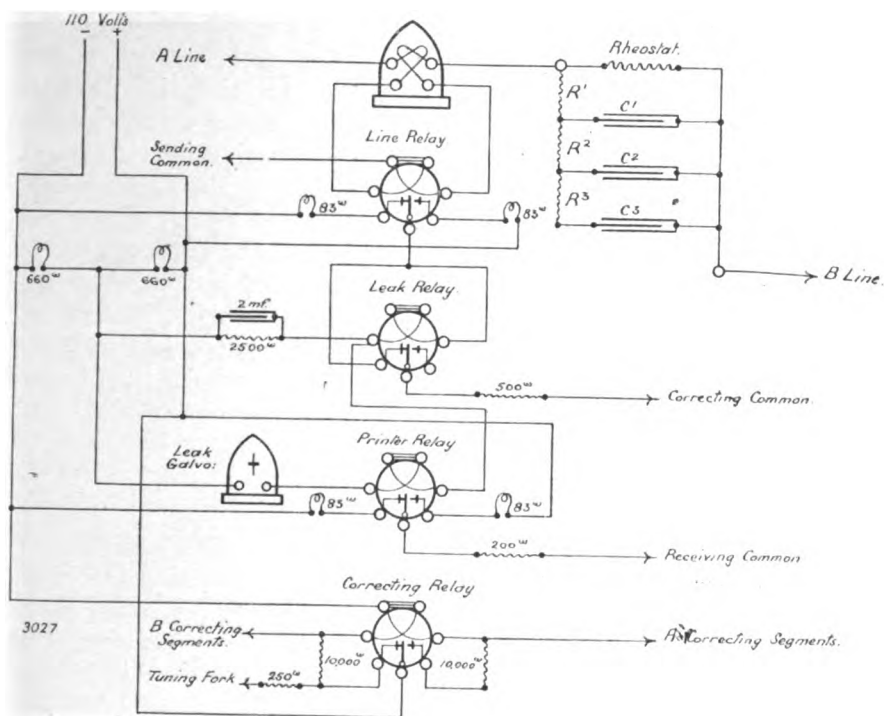
2.—ELECTRICALLY VIBRATED TUNING FORK.

electrically operated rubber-tipped buffer striking the vibrating fork, momentarily increasing the rate of vibration and preventing the motor from running out of phase.

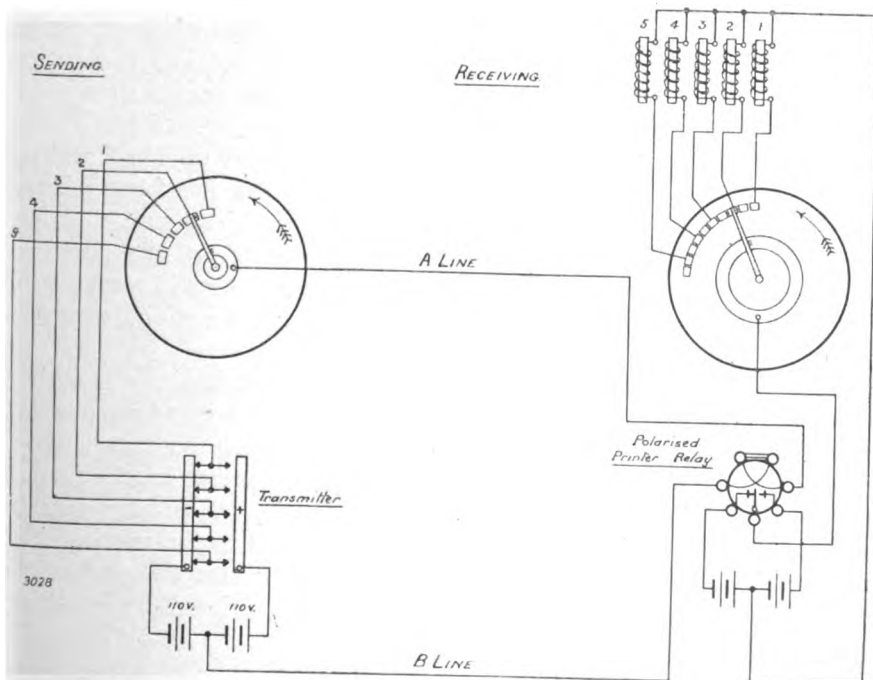
It is a feature of the system that correction is brought about by the working line signals, no special segments on the sending and receiving rings being appropriated to this purpose. Consequently there is no loss of valuable line time in securing correction.

The third ring of the distributor has its twenty segments divided between the four transmitters, and is known as the sending ring. Each quadrant of the ring serves one arm of the multiplex; the five segments of one quadrant are therefore joined to the five contacts of a transmitter. One of the pair of brushes allotted for sending is connected through a solid ring to the "split" of the line relay (3), while the other sweeps over the segments and thus joins each in turn to the line and compensation circuits in the usual

TYPE-PRINTING MULTIPLEX TELEGRAPH. TELEGRAPHS



3.—THEORETICAL DIAGRAM OF AUXILIARY APPARATUS.



4.—THEORETICAL DIAGRAM OF LOOP CIRCUIT.

differential duplex manner. The portion of the current passing to line actuates a polarised relay at the receiving station, which repeats the received currents through the common receiving ring, brushes and segments to the selecting relays of the printer served by the particular set of segments concerned in the operation (4).

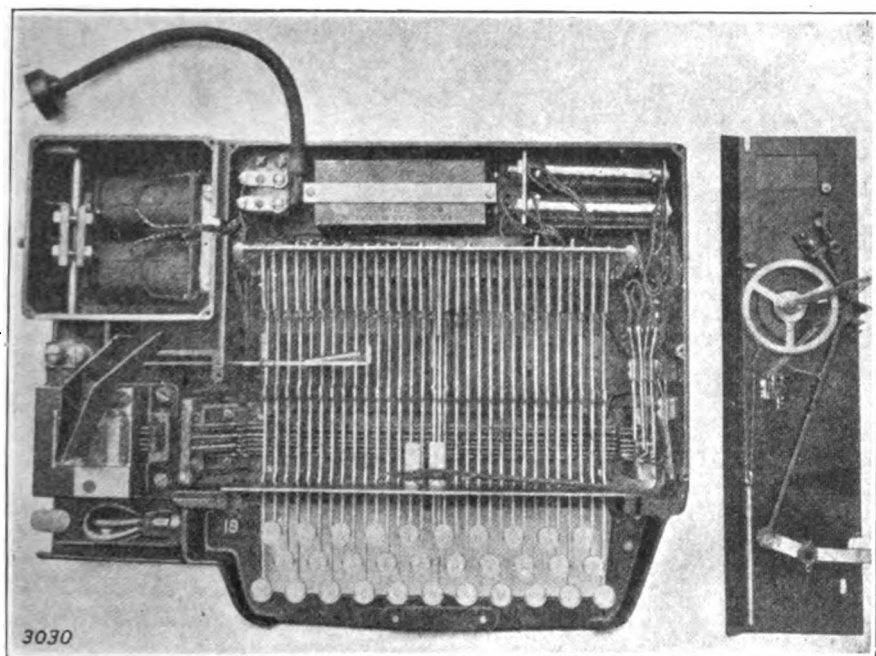
The fourth segmental ring is known as the "local." Its function is to complete the actual printing of the selected signal, release the relays and move the paper forward in readiness to receive another signal from line. The local ring also controls the movement of the perforated paper slip through the transmitter as explained later.

THE KEYBOARD PERFORATOR (5, frontispiece), consists of three rows of keys carrying primary and secondary symbols, the change from one to the other being effected by the depression of "letter shift" and "figureshift" keys. The "touch" of the keys is light and the depth of travel small, so that the instrument may be worked for long periods without causing fatigue.

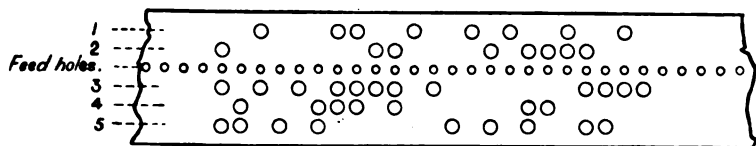
When a key is depressed the internal mechanism (6) selects one or more of the punches, and at the end of the downward stroke an electrical circuit is closed which energises the perforating magnet and causes the selected punches to cut through the paper. The signals are perforated across the slip, and not, as in the Wheatstone system, along its length. To illustrate the saving in paper by adopting cross punching, the words "Post Office Telegraphs" are shown perforated by the two methods in 7.

Special signals are provided for "line feed" and "carriage return." The first of these causes the paper on the receiving printer to be stepped up for a new line, while the second draws the paper carriage to the right. In order that the keyboard operator may not punch too many words in one line, an indicator is fitted just above the keyboard to show the number of letters already punched, and as a further precaution a signal lamp fixed at the left front of the perforator glows when the maximum number of signals allowed for one line is approached. When this lamp lights up, the puncher depresses the "line feed" and "carriage return" keys in succession; this resets the pointer of the indicator at zero and extinguishes the lamp.

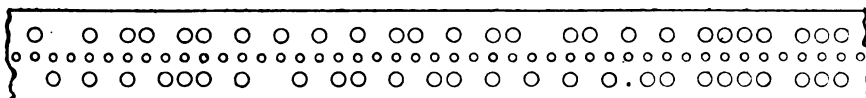
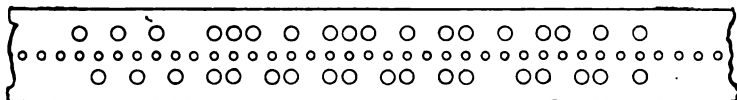
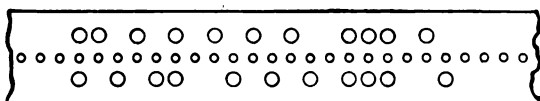
THE AUTOMATIC TRANSMITTER (8).—The transmitter contains five movable contacts somewhat similar in character and purpose to the tongue of a telegraph standard relay. Each contact is connected, as already stated, to a separate segment in the same quadrant of the sending ring of the distributor. Normally, all the contacts or tongues rest against a bus bar joined to the spacing side of a double battery (9). On starting the transmitter the perforated slip is moved forward letter by letter by the action of a star wheel which engages with feed holes in the paper.



6.—KEYBOARD MECHANISM.



CROSS PERFORATION

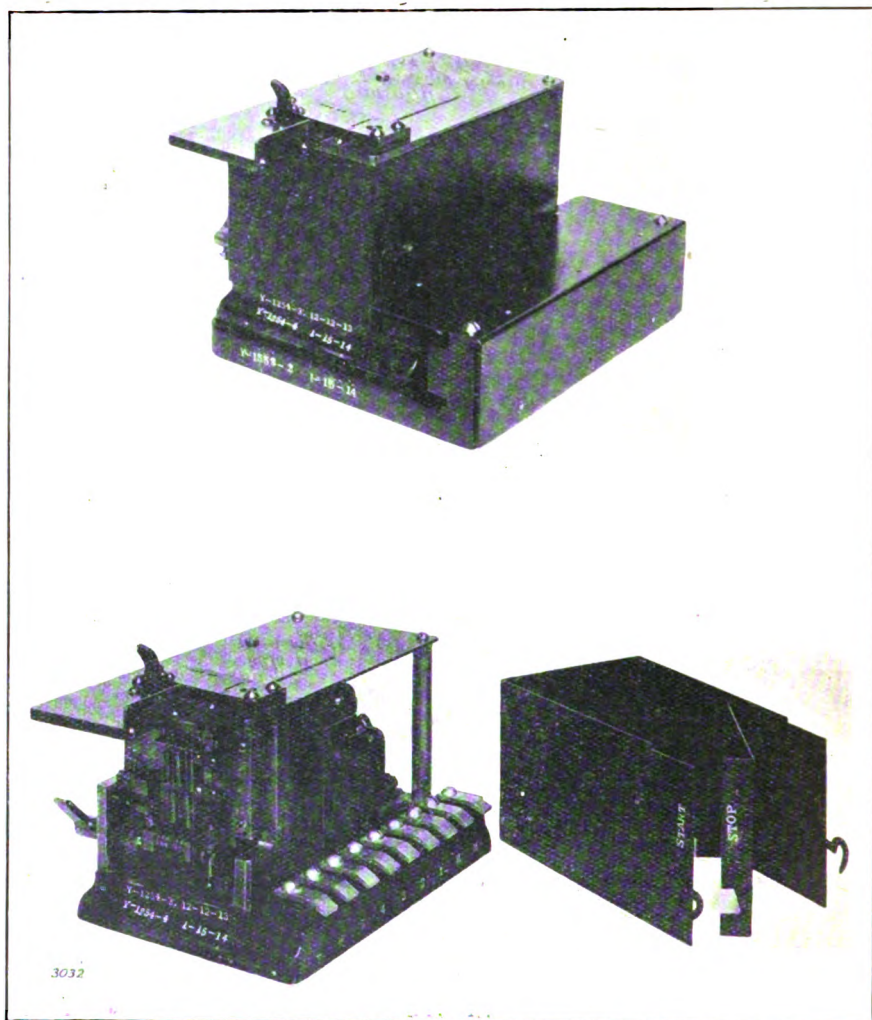


WHEATSTONE

7.—COMPARISON OF PERFORATED SLIPS.

TELEGRAPHS TYPE-PRINTING MULTIPLEX TELEGRAPH.

At each step one or more of the selecting rods rise through the perforations and cause the transmitter contacts which they control to pass over to the marking bus bar, the remaining rods not being free to rise retain their respective contacts on the spacing side.

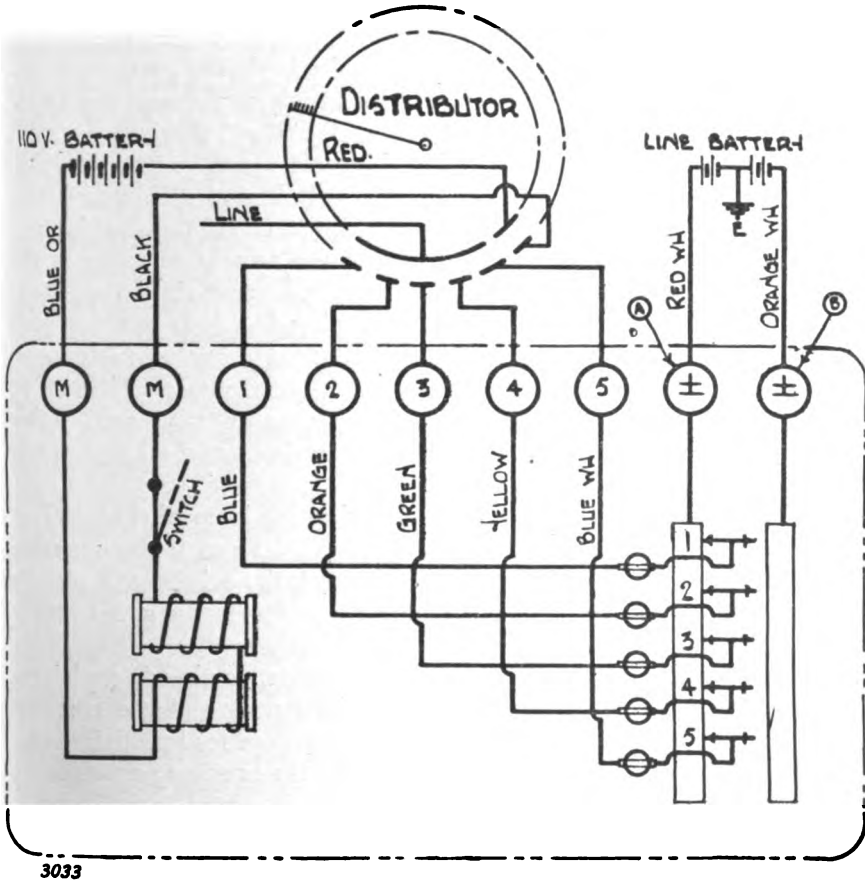


8.—AUTOMATIC TRANSMITTER.

For instance, to signal the letter "A," holes are punched in positions 1 and 2 (7), and on the slip passing through the transmitter, rods 1 and 2 project through the holes and move contacts 1 and 2 to the marking side, while 3, 4, and 5 remain on the spacing bar. The sending brush of the distributor passing over each segment in turn connects it to line and causes the same combination of momen-

TYPE-PRINTING MULTIPLEX TELEGRAPH. TELEGRAPHS

tary currents to pass through the receiving relay at the distant end. Immediately the fifth sending segment of one quadrant has been passed by the sending brush, a circuit is completed through the transmitter feed magnet and local rings of the distributor, for the purpose of feeding the paper forward and allowing the rods to set up



9.—INTERNAL CONNECTIONS OF AUTOMATIC TRANSMITTER.

the proper selection for the next letter during the time the sending brushes are passing over the segments of the other three quadrants.

In addition to the usual "start" and "stop" switch there is a second switch, marked "on" and "off," in the base of the instrument. If a piece of perforated slip is in the transmitter with the first switch at "start" and the second switch in the "off" position, the letter selected will be sent once for each revolution of the brushes, but the paper will not be moved forward, as the feed magnet will remain disconnected. This is found convenient during speed trials and for testing purposes.

TELEGRAPHS TYPE-PRINTING MULTIPLEX TELEGRAPH.

For ordinary traffic the base switch must, of course, be in the "on" position.

Adjacent transmitters send currents of opposite polarity for marking. Thus, if instrument No. 1 sends positive marking, No. 2 will send negative marking, and so on. This causes frequent reversal of current and thus ensures the action of the correcting mechanism under all conditions.

AUTO-CONTROL SWITCH.—Between the keyboard perforator and the transmitter an automatic switch is fitted to prevent the transmitter tearing the paper in the event of the slip being drawn tight through the transmitter overtaking the perforator.

A light metal arm projects from the switch, and underneath this the slip passes on its way to the transmitter. If tension for any reason be applied to the paper, the switch arm is raised and the paper-moving circuit disconnected. At the same time the transmitter contacts are brought to the spacing bus bar, and for each revolution of the brushes spacing current only passes to line. A small electric lamp in the upper part of the instrument lights up to indicate to the operator that the slip has ceased running. When the tension on the paper is relaxed the arm drops and allows signals to be again transmitted.

The printer at the distant office, during the interval that spacing currents only are received, remains inactive. Even if the cessation occurs in the course of transmitting a word, the printer will pick up at the correct point and continue without leaving a gap to show where the transmitter stopped.

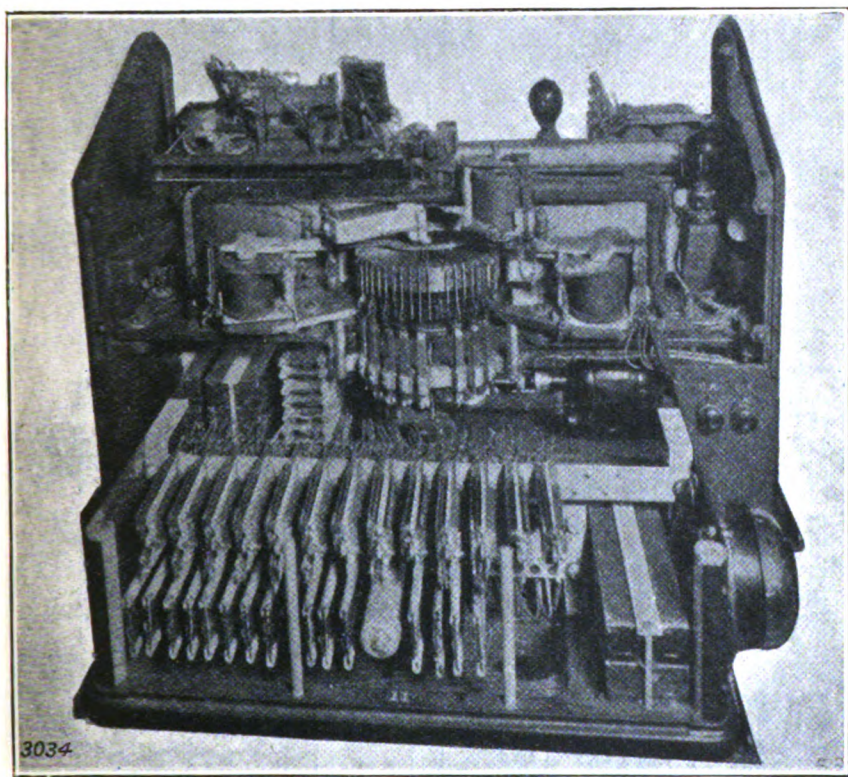
THE PRINTER (10).—The received currents, as already explained, are repeated through a post office standard relay and the common receiving ring to the receiving segments, each of which has a separate selecting relay in its circuit. As the brushes pass over the segments, selection takes place in the same sequence as the currents are sent out by the distant transmitter.

The type-wheel of the printer is carried on a vertical spindle driven by a spring movement, a small electric motor being employed to maintain the necessary torsion of the spring.

The printing of the correct symbol is brought about in the following manner: A set of five skeleton discs, slotted at their outer edges and capable of horizontal movement through a small angle, are arranged one above the other. Outside and surrounding the discs a number of levers, shaped like an inverted letter L and supported at their angles, are placed in such order that a limb of each lever may fall into the recesses when five slots (one in each disc) are in a direct line underneath it.

The selecting relays, acting through separate electro-magnets contained inside the printer case, control the horizontal movements of

the discs, and by the combination of positive and negative currents, a selection is set up which results in one of the levers being free to enter the slots. This causes a stop to project in the path of the type-wheel carrier. The type-wheel spindle is then released, and revolves until it reaches the stop. This brings the selected character into position for printing, and the paper is forced into contact with the type wheel by a blow from a rubber-tipped bar.



10.—INTERIOR OF PRINTER AND RELAY BOX.

Immediately the letter has been printed, the lever is released from the discs, and the paper moves forward to receive the next signal.

A continuous roll of paper, $8\frac{1}{2}$ in. in width, is fitted behind the printer, and as each message is completed it is cut off by the receiving operator drawing the paper against a fixed cutting edge.

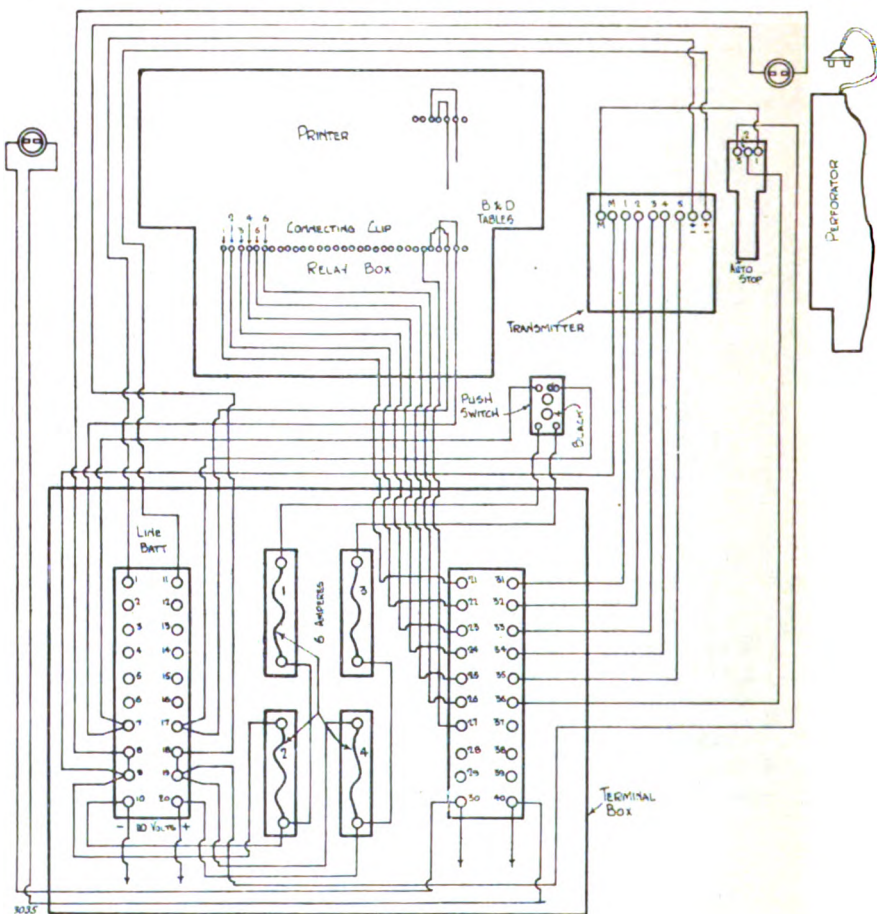
To give the receiving operator full control over the printer, two press buttons are fitted at the side of the instrument. One of these feeds up the paper, one step for each depression; the other works the carriage return mechanism.

The selecting relays are contained in a box, which stands in

TELEGRAPHS TYPE-PRINTING MULTIPLEX TELEGRAPH.

front of the printer, the top of the box being of suitable height for use as a writing desk. The separation of the relay-box from the printer permits of the two parts being independently changed.

To avoid the necessity of punching requests for messages to be re-run or re-perforated, a bell is fitted at one side of the relay-box,



II. — COMPLETE WIRING DIAGRAM OF ONE ARM.

and by sending special signals, the bell is rung from one to five times, the number of strokes indicating what is required, as shown below :

- 1 ring. Re-run last message.
- 2 rings. Re-run message now being transmitted.
- 3 „ Re-punch last message.
- 4 „ Re-punch message now being transmitted.
- 5 „ Stop sending.

The wiring of a complete arm set is shown in II.

The following traffic returns, which bear eloquent testimony to

TYPE-PRINTING MULTIPLEX TELEGRAPH. **TELEGRAPHS**

the stability of the system, show the hourly totals for one day's work, and the weekly totals for the period May 31st, 1915, to July 3rd, 1915:

STATEMENT SHOWING THE HOURLY TOTALS OF TRAFFIC DEALT WITH ON THE TS-MANCHESTER QUADRUPLE DUPLEX CIRCUIT ON THE 16TH JULY, 1915.

Hour.	Forwarded to Manchester.	Received from Manchester.	Total.
8-9	55	42	97
9-10	104	180	284
10-11	283	190	473
11-12	233	204	437
12-1	260	224	484
1-2	241	211	452
2-3	250	205	455
3-4	252	244	496
4-5	248	221	469
5-6	216	184	400
6-7	208	165	373
7-8	198	172	370
8-9	173	132	305
Daily Totals	2721	2374	5095

STATEMENT SHOWING THE NUMBER OF TELEGRAMS PASSING OVER THE TS-MANCHESTER QUADRUPLE DUPLEX CIRCUIT WEEKLY DURING THE PERIOD FROM MAY 31ST, 1915, TO JULY 3RD, 1915, INCLUSIVE.

(Note.—The circuit was not worked on Sundays.)

Week.	Forwarded to Manchester.	Received from Manchester.	Total.
May 31st to June 5th . . .	14,095	11,813	25,908
June 7th to June 12th . . .	13,025	10,711	23,736
June 14th to June 19th . . .	14,217	12,740	26,957
June 21st to June 26th . . .	14,856	12,064	26,920
June 28th to July 3rd . . .	15,092	12,980	28,072
Totals	71,285	60,308	131,593

It should be mentioned that the number of working channels is varied to meet the flow of traffic during the early morning and late evening hours.

A. H. ROBERTS.



332

LONDON-BIRMINGHAM LOADED CABLE.

RESULTS OBTAINED IN THE FINAL TESTS.

THIS cable is now completed and working satisfactorily. Readers of the JOURNAL are reminded that the scheme for a Post Office loaded underground telephone cable between London and Birmingham is described by Mr. Hilyer in vol. 7, part 1, p. 32. The difficulties to be overcome in balancing such a cable to make it suitable for superimposing, and the means taken to achieve the desired object, are dealt with by Mr. Pollock in his articles on "The Balancing of Telephone Cables" in vol. 7, part 1, p. 66, and vol. 7, part 4, p. 357. The following notes and tabulated results of actual tests on the completed cable will no doubt be of interest to many readers.

The completion of the London-Birmingham cable marks the first stage in the realisation of the scheme for connecting London with Liverpool by means of an underground telephone cable. It may be mentioned that the Birmingham-Liverpool section is also advancing towards completion.

The cable and loading scheme was designed by the Post Office engineers. The work between London and Birmingham was entrusted to the Western Electric Company, who provided and balanced the cable and supplied and fixed the loading coils. Further north the cable work is in the hands of the Helsby Cable Company.

There are 52 telephone pairs in the cable along the entire route, divided as follows:

2 direct circuits on 300 lb. conductors.

14	„	„	200	„
12	„	„	150	„
24	„	„	100	„

In addition, 12 of the 100 lb. and all the 150 lb. circuits, 12 in number, carry superimposed or phantom circuits (6 phantom circuits in each of the two groups), and provision has been made by

LONDON-BIRMINGHAM LOADED CABLE. TELEPHONES

auxiliary stubs at the loading points for adding further phantom circuits as required.

The following table shows the mean results of direct and alternating current tests which have been made on the entire cable, and gives exact comparative values for the efficiency of the various circuits under the heading of the attenuation constant " β ."

DIRECT AND ALTERNATING CURRENT TESTS. MEAN RESULTS.

Cable Length = 109.5 Miles.

Weight, per mile, per wire (lb.).	Diameter.		Direct current tests.				Alternating current tests ($\omega f = 5000$).
	Inches.	Mm.	Resistance, ohms per mile (loop).	Inductance, henrys per mile (loop).	Insulation, megohms per mile (loop).	Capacity, mf. per mile (loop).	Attenuation, constant β per mile.
300	.137	3.48	6.55	0.055	21800	0.0568	0.00408
200	.112	2.841	9.62	0.054	19000	0.0655	0.00664
150	.097	2.461	13.13	0.054	17890	0.0697	0.00884
150	Phantom	Phantom	6.56	0.035	—	0.1057	0.00756
* 100	.079	2.009	18.38	0.053	20600	0.0568	0.01074
100	Side	—	18.95	0.054	—	0.0575	0.01092
100	Phantom	Phantom	9.5	0.036	—	0.0905	0.00926
200	"	Not yet loaded	Not yet loaded	Not yet loaded	Not yet loaded	0.0823	—
300	"	Do.	Do.	Do.	Do.	0.0844	—

* Not phantomd.

The mean measured characteristic impedance of the direct circuits is 900ω . The measured values varied from 880ω to 1030ω . The mean values for the phantom circuits is 586ω .

The maximum resistance allowed in the loading coils at 800 periods per second is 50 ohms per henry ($\frac{R_1}{L_1} = 50$), except in the case of the 300 lb. circuits, where the maximum resistance allowed is 35ω per henry ($\frac{R_1}{L_1} = 35$), R_1 being the effective resistance of the coil and L_1 its inductance in henries. The maximum value of $\frac{S}{K}$ is

20. These values were given by the contractors and verified by factory tests. The coil spacing distance of $2\frac{1}{2}$ miles was adhered to throughout except at the cable ends, where it is $1\frac{1}{2}$ miles.

Having given the above data, it is of interest to compare the anticipated attenuation constants as calculated by the Post Office Engineers (and given in Mr. Hilyer's article referred to above) with the measured values in the preceding table. For convenience of reference the figures are reproduced below.

TELEPHONES LONDON-BIRMINGHAM LOADED CABLE.

MEASURED AND CALCULATED VALUES OF THE ATTENUATION CONSTANT.

Weight, per wire, per mile (lb.).	Calculated value of attenuation constant.	Measured value of attenuation constant.	Percentage difference from calculated value.
300	0'0048	0'00408	20 per cent. better.
200	0'00684	0'00664	3 per cent. better.
150	0'00875	0'00884	1 per cent. worse.
150 phantom	0'00759	0'00756	No difference.
100 direct cct.	0'01161	0'01092	7 per cent. better.
100 phantom	0'00926	Not calculated	—

It will be seen that except in the case of the 300 lb. circuit the differences are small. In the case of the 300 lb. circuit the capacity obtained was materially lower than anticipated (055 mf. per mile instead of 065 mf.). The only other difference in the treatment of this circuit is that a higher grade coil was used.

It may be remarked that the same efficiency may be obtained by the combination of various proportions of copper and inductance per mile. Loading coils of various grades and prices are available for selection. The plan followed was to give the preference to a combination which secures a relatively large proportion of copper to inductance for a given efficiency and price, copper being a more stable asset than coils. This method also reduces to a minimum the effect of distortion caused by effective resistance in the coils, and secures a favourable characteristic impedance for working in connection with the general system. The grade of speech obtained is found to be satisfactory with the spacing named.

So far as any details are known to have been published it may be stated that the efficiency of the 300 lb. circuit, per unit length, is higher than that of any other existing underground circuit. This is principally because the copper used has a greater weight per mile than any other loaded circuit known. The result is also contributed to by the high grade coils used, and the relatively low capacity of the circuit.

It will be noticed that the phantom circuits are more efficient than the direct circuits on which they are superimposed. This is because of the favourable capacity of the phantom circuit, *i. e.* its resistance is halved, but its capacity is not doubled, as compared with the direct circuits; this is advantageous from the transmission efficiency point of view.

SPEECH TESTS.

It is generally assumed that the attenuation due to speech corresponds to that which is observed in telephone circuits when an

alternating current at a frequency of 800 periods per second is transmitted along them. The following table shows to what extent this was found to hold good in this case. The figures in the first line of the table are the results of speech tests made on the circuits in the cable, and compared with a standard cable. The results for each type of cable are expressed in terms of their standard cable equivalents (S.C.E.). The machine tests in the preceding table, which were made at a frequency of 800 periods per second, are reduced to "S.C.E.," and given for comparison on the second line of the table:

COMPARISON OF SPEECH TESTS AND MACHINE TESTS
(LONDON-BIRMINGHAM).

	Type of conductor.					
	300 lb.	200 lb.	150 lb.	150 lb. phantom.	100 lb.	100 lb. Side. 100 lb. phantom.
S.C.E. of circuit deduced from speech tests.	4.7	7.4	9.5	7.9	11.3	11.6
S.C.E. of circuit deduced from machine tests.	4.25	6.92	9.22	7.89	11.21	11.39

Not phantomed.

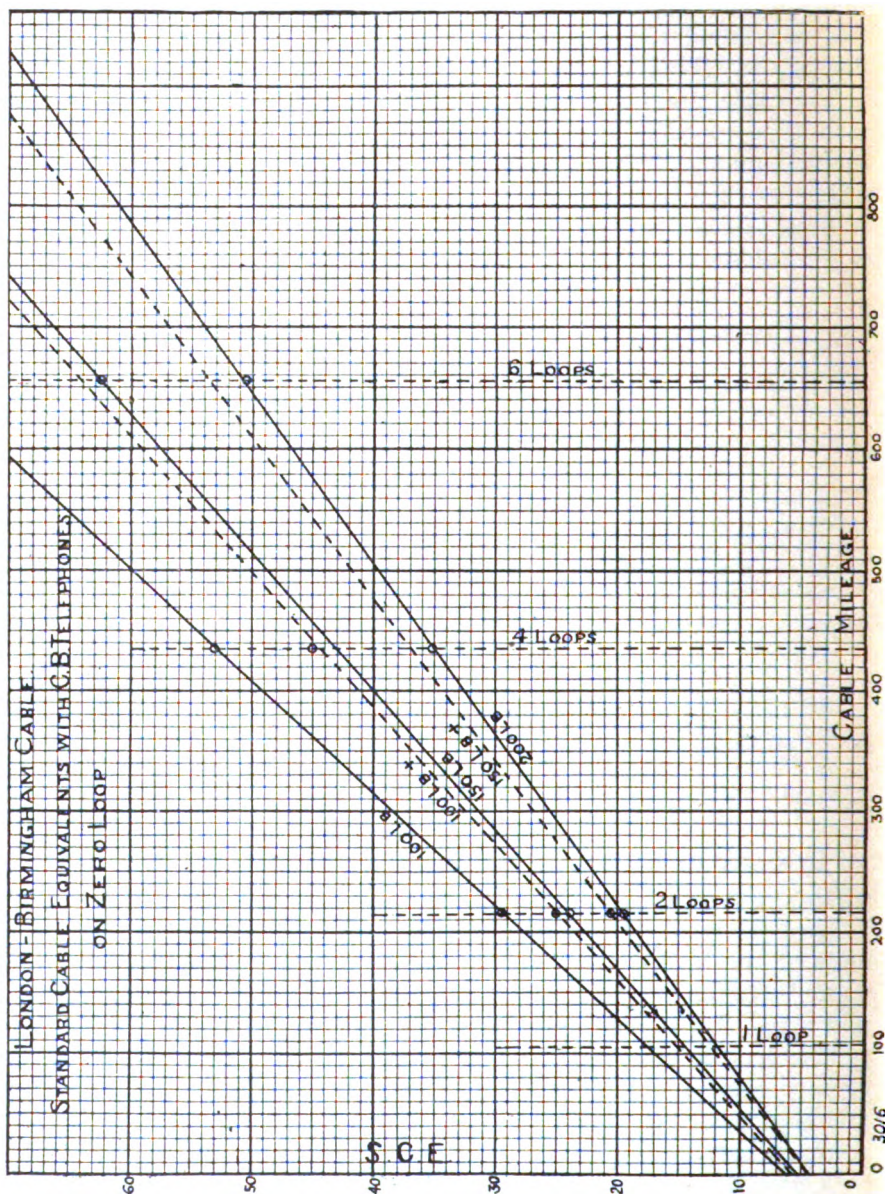
If the difficulty and limits of error of standard cable tests are borne in mind the agreement is good.

TERMINAL LOSSES.

In order to investigate the terminal losses, the usual graphical method was resorted to, and **1** and **2** show the results.

In **1** the result of speaking with the apparatus immediately at the ends of the loaded lines is seen, the terminal loss is the "S.C.E." value between the point where the graphed lines strike the vertical, and zero. Its average value is six miles of standard cable. Owing to the length of cable, it was not possible to obtain more than three points on the curve in any case. For this reason the values are somewhat approximate. The circuit used was the standard common battery circuit.

Curve No. 2 shows the terminal loss in connection with the same local circuit, but with a subscriber's line of 350 ohms resistance. In the case of direct circuits the average loss is reduced to 0.8 miles of standard cable. In the case of the phantom circuit the result is 2 msc. With transformers for superimposing added the mean losses are increased by $1\frac{1}{2}$ msc. It will be seen that the Standard cable tests give practical figures for commercial use.

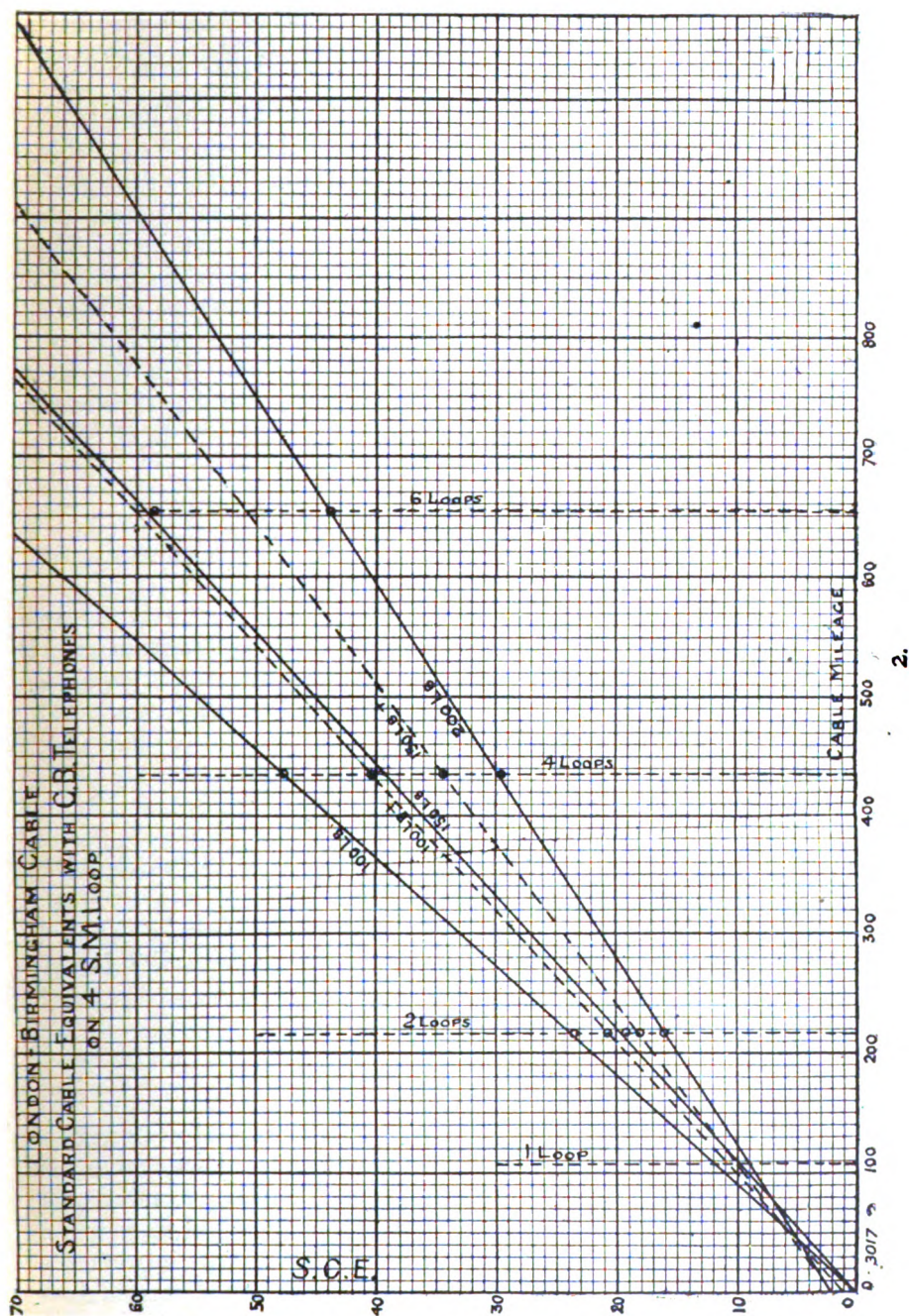


CROSS-TALK TESTS.

The tests were of two kinds:

(a) Between all combinations of the direct circuits; (b) between the phantom and direct circuits, and *vice versa*.

LONDON-BIRMINGHAM LOADED CABLE. TELEPHONES



In the first case the maximum cross-talk was no greater than would be observed when speaking through 80 miles of standard cable. In the second case the maximum overhearing was equal to 67 miles of standard cable.

Both these figures are far beyond the commercial limit of speech. The mean values are, however, very considerably better than these figures.

It may be mentioned that such results would be quite impossible without special care in the manufacture and balancing of the cable. In fact, the progress which this cable marks over others previously laid in this country consists largely in the relatively small cross-talk and the reduction of leakance which have been obtained. The former has the important result of making phantom working possible, and the latter brings about decrease in the attenuation constant, with a corresponding increase in the possible range of telephonic speech. These results were foreseen and expected. The Western Electric Co. are to be congratulated on the successful performance of the work entrusted to them.

J. G. H.

ERRATA.

IN connection with the article describing the "Termination of the Loaded Trunk Telephone Cables," which appeared on page 110 of the July, 1915, issue of the JOURNAL, the following errata and note have been furnished by the author:

ERRATA.

Fig. 5.—A connection should be inserted between the right-hand terminal of the receiver "C" of the transformer.

Fig. 6.—The bridge ratio arms should have the value 50·05 ohms.

Page 111, para. 1 should read . . . "the 100 lb. and 150 lb. loops . . . EIGHTEEN loaded phantom circuits . . . and eight unloaded phantom circuits. . . ."

NOTE.

It has been decided to form independent phantom circuits—London to Birmingham and Birmingham to Liverpool—upon certain loops which will be used as through circuits between London and Liverpool. To enable the phantom circuit connections to be taken out at the intermediate point, it has been necessary to introduce a new type of transformer, having six highly insulated terminals—three on the up-winding and three on the down-winding. These will be known as "Transformer No. 5," and will be similar in dimensions and general make up to the "Transformer No. 3" illustrated in the article.

THE INCOMPLETENESS OF THE PRESENT THEORY OF TELEPHONE TRANSMISSION.

By F. MURPHY, B.Sc.

(Continued from p. 127.)

IN the previous article the writer pointed out that the present *βl* rule is incomplete in so far that it takes no account of the part played by the induction coil in speech transmission.

Experiments have therefore been made to ascertain the behaviour of the induction coil under various conditions. The tests have, so far, been confined to the local battery case, as this is the simpler problem.

The first measurements were made under the following conditions:

- (1) Continuous current in the primary constant.
- (2) Alternating current in the primary constant.
- (3) Frequency of alternating current in the primary constant, but the secondary was closed through different non-inductive resistances.

I shows the connections employed. The numbers 1, 2, 3, 5 and 6 refer to the contacts of the switches connected to corresponding points of the circuit. The 10^Ω non-inductive resistance was used to measure the primary A.C. by the volt drop on it. The six terminal, two-position switch was introduced to ascertain the extent to which the results were dependent on the direction of the continuous current. The primary alternating current was supplied through a second induction coil to prevent the continuous current passing through the Franke machine.

It was found that the difference in the reading due to reversing the C.C. was of the same order as the experimental errors. The results given below are consequently the average of two sets of readings, one taken with the continuous current flowing in one direction, and the other with it reversed.

The continuous current was kept at 200 mas., and the frequency of the alternating current at 800 ~ per sec.

TABLE I.

Primary.					Secondary.				Efficiency, per cent.
Volts.	Current in mas.	Angle of lag.	Cos φ.	Input, milliwatts.	Volts.	Resistance of lead.	Current in mas.	Output, milliwatts.	
1'41	32'9	78° 57'	191	8'89	2'69	1600	1'68	4'53	51'0
1'41	33'0	77° 54'	210	9'75	2'65	1400	1'89	5'02	51'5
1'27	30'5	75° 21'	253	9'80	2'41	1000	2'41	5'81	59'3
1'26	30'4	73° 51'	278	10'68	2'36	800	2'95	6'98	65'3
1'25	30'4	70° 34'	333	12'64	2'28	600	3'80	8'68	68'6
1'18	30'7	64° 56'	424	15'35	2'13	400	5'33	11'36	74'0
1'07	32'6	53° 13'	599	20'9	1'74	200	8'70	15'16	72'5
275	29'8	51° 58'	616	51	0	0	—	0	0

TELEPHONES THEORY OF TELEPHONE TRANSMISSION.

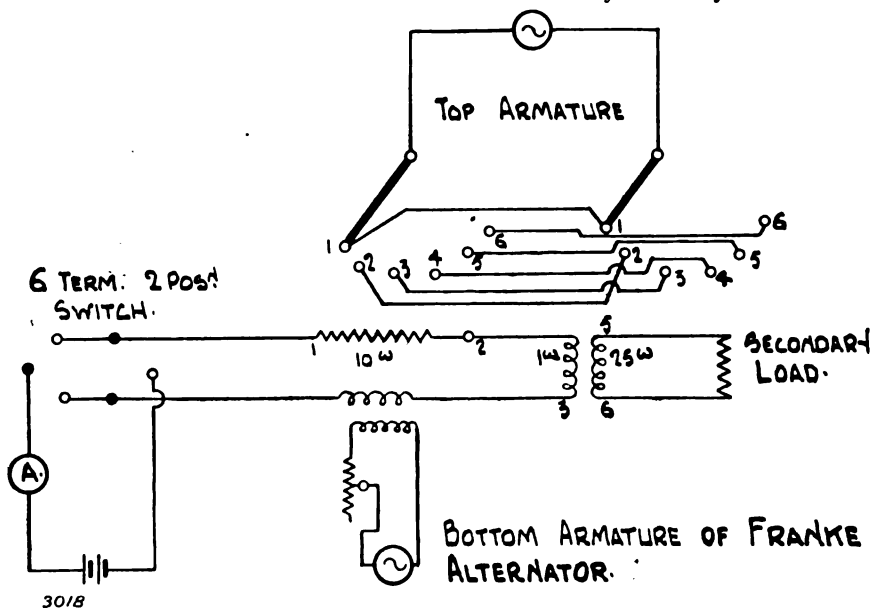
It will be seen, therefore, for these conditions :

(1) That the efficiency is comparatively high.
 (2) That the secondary voltage is approximately constant for fairly varying secondary loads.

(3) That for constant primary alternating current, the secondary current is by no means constant with varying secondary resistances.

Table II gives the results of a similar test made on a second induction coil of the same type, viz. $\frac{I^w}{25^w}$.

It will be seen that this second coil behaved very similarly to the first.



I.

TABLE II.

Primary.					Secondary.				Efficiency, per cent.
Volts.	Currents in mas.	Angle of lag.	Cos ϕ .	Input, milliwatts.	Volts.	Resistance of load.	Current in mas.	Output, milliwatts.	
830	28.1	75° 58'	.242	5.66	2.18	1400	1.56	3.39	59.7
825	28.1	74° 21'	.270	6.25	2.16	1200	1.80	3.88	62.1
810	28.2	72° 29'	.301	6.87	2.09	1000	2.09	4.35	63.3
792	28.6	69° 23'	.352	7.98	2.03	800	2.54	5.14	64.3
740	28.6	65° 12'	.419	8.85	1.89	600	3.15	5.94	67.0
656	28.7	57° 57'	.531	10.0	1.64	400	4.10	6.71	67.1
602	28.7	52° 12'	.613	10.6	1.46	300	4.87	7.10	67.0
485	28.2	44° 48'	.705	9.62	1.13	200	5.65	6.37	66.3
345	28.5	37° 0'	.709	7.86	.680	100	6.8	4.72	60.0
123	28.2	44° 34'	.702	2.43	.075	10	7.5	.56	23.1
126	28.2	56° 14'	.604	2.27	0	0	—	0	0

2 gives curves showing the efficiency at corresponding secondary loads.

Table III gives the results of a test made on this second coil to ascertain the effect of varying the primary continuous currents.

TABLE III.

C.C. in mas.	Primary.			Secondary.			
	A.C. volts.	Angle of lag.	Input, milliwatts.	Volts.	Current in mas.	Output, milliwatts.	Efficiency, per cent.
200	800	64° 39'	9'75	1'93	3'22	6'21	63'7
150	797	64° 34'	9'74	2'00	3'33	6'65	68'2
100	780	64° 56'	9'41	1'93	3'22	6'21	66'0
50	800	65° 1'	9'64	1'98	3'30	6'51	67'5
0	780	65° 16'	9'30	1'96	3'27	6'36	68'3

The frequency was again 800 ~ per sec., the primary A.C. 28'5 mas., and the secondary resistance was 600^m.

It will be seen that the action of the coil is practically independent of the values of the continuous current in the primary.

Observations were next made with varying A.C. in the primary, the C.C. being kept constant at 200 mas., the secondary resistance at 600^m and the frequency 800 ~ per sec.

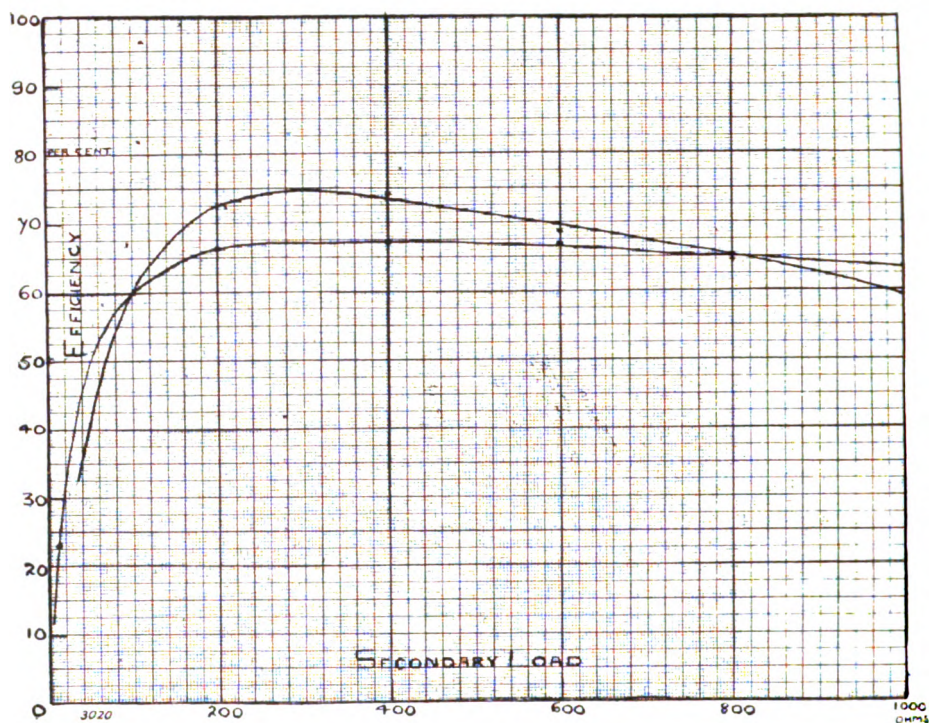
The results are given in Table IV. They show that the secondary voltage is approximately proportional to the primary A.C. and that the efficiency of the coil is high throughout the range of primary A.C. taken.

Tests were next made to ascertain the behaviour of the coil when the secondary was closed through impedances, chosen to represent the characteristic impedances of various types of open and underground line.

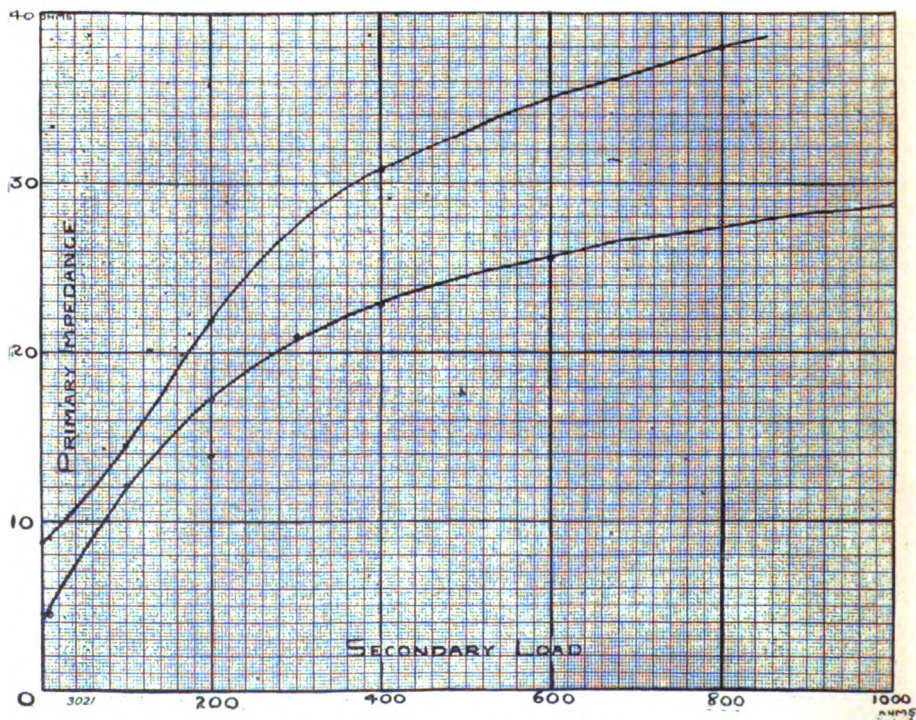
TABLE IV.

Current in mas.	Primary.				Secondary.			Efficiency, per cent.
	Volts.	Angle of lag.	Cos ϕ .	Input, milliwatts.	Volts.	Current in mas.	Output, milliwatts.	
9'8	292	65° 47'	411	1'18	700	1'16	82	70'6
18'5	575	65° 1'	422	4'50	1'250	2'08	2'62	58'3
26'0	750	64° 40'	428	8'33	1'926	3'21	6'20	74'3
32'7	930	64° 34'	432	13'1	2'448	4'08	10'0	76'5
39'1	1'140	64° 7'	437	19'5	2'900	4'83	14'05	72'3
44'1	1'304	62° 59'	454	26'3	3'320	5'20	18'4	70'0
48'8	1'452	63° 51'	441	31'2	3'680	6'13	21'4	68'6
50'8	1'559	63° 54'	440	37'1	4'056	6'76	27'5	74'2
58'0	1'710	63° 43'	443	43'9	4'360	7'26	31'7	72'3
49'5	1'461	64° 8'	436	31'6	3'696	6'16	21'6	68'5
1'5	048	67° 26'	384	028	122	20	0067	14'0

TELEPHONES THEORY OF TELEPHONE TRANSMISSION.



2.



3.

The primary C.C. and A.C. were kept constant at 200 mas. and 30 mas. respectively, and the frequency at 800 ~ per sec.

The results are given in Table V. The impedance through which the secondary was closed consisted of a non-inductive resistance in series with a condenser. It will again be observed that although the secondary current varies considerably, the secondary voltage is approximately constant.

Further, if the values of secondary volts be plotted against those of secondary impedances, a smooth curve can be drawn through the points so obtained. This rather implies that the secondary current depends mainly on the magnitude of the secondary impedance and not on its phase angle.

TABLE V.

Approximate equivalent line.	Secondary.						Primary.		
	Load.			Impedance.	Volts.	Current in mas.	Volts.	Current in mas.	Angle of lag.
	Resistance.	Capacity.	Angle of lead.						
Ug.	Ohms.	Mfds.							
10	510	.40	38° 45'	665	2'624	3.97	1'356	30.6	79° 12'
20	410	.5	41° 28'	548	2'808	5.09	1'444	29.8	68° 25'
40	300	.75	39° 24'	388	2'760	7.12	1'440	29.5	60° 9'
70	220	1.10	37° 52'	279	2'508	9.35	1'372	29.4	50° 14'
150	160	1.84	32° 23'	189	2'160	11.38	1'176	29.6	39° 36'
200	150	2.48	27° 14'	169	1'928	11.25	1'080	30.0	39° 4'
OH.	1250	2.07	3° 56'	1251	2'408	1.61	1'280	30.5	77° 14'
40 B ₂	1250	.21	37° 54'	1585	2'640	1.67	1'356	30.3	77° 1'
70 B ₂	1000	.31	32° 59'	1190	2'624	2.19	1'360	30.3	76° 48'
100 C.	1760	.72	19° 30'	806	2'480	3.08	1'308	30.2	73° 13'
—	700	2.05	7° 26'	706	2'568	3.32	1'260	30.4	71° 36'
300	640	2.09	8° 17'	647	2'552	3.03	1'256	30.3	70° 35'
600	590	4.40	3° 58'	592	2'280	3.88	1'232	30.3	70° 1'

3 shows the curves obtained by plotting secondary load against primary impedance. It will be observed that as the resistance of the secondary load decreases, the primary impedance falls away gradually at first and finally quite rapidly.

It is desirable to simultaneously consider the following two effects, and in the writer's opinion they are the cause of terminal loss or gain at the sending end.

(1) For constant A.C. in the primary, the secondary current varies inversely as the impedance of the secondary load.

(2) The primary impedance varies directly as the impedance of the secondary load.

Consider now the conditions obtaining in local battery instruments which are being used to compare two lines. The speaker endeavours to speak in the same tone of voice when speaking on either of the lines, in other words, an endeavour is made to cause

the transmitter resistance to vary in precisely the same way, when speaking on either line.

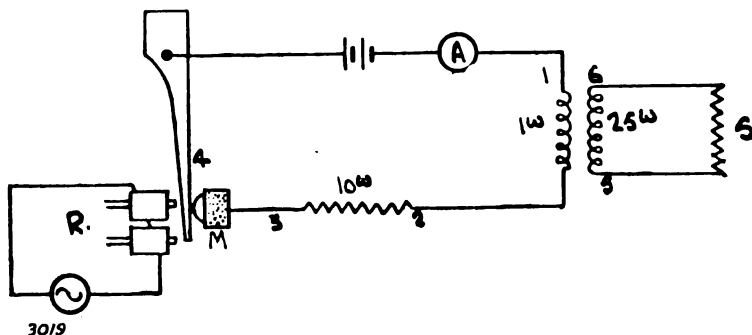
If, therefore, in a transmission test, it is assumed that the resistance of the microphone is varying in a certain definite way throughout, it can be shown that the extent of the variations in the primary current depend also on the impedance of the secondary load.

For consider the case of a circuit consisting of a battery, a microphone and an inductance only.

Let R = total resistance of the circuit where the microphone is in a steady condition.

I = current flowing under these conditions.

L = self-induction of the circuit.



4.

Let the resistance change an amount ΔR in a time Δt , then the volts dropped on the resistance of the circuit, viz., Ri will change by an amount

$$R\Delta i + i\Delta R$$

This is equal to the back E.M.F. of self-induction set up, viz.,

$$- L \frac{\Delta i}{\Delta t}$$

$$\therefore R\Delta i + i\Delta R = - L \frac{\Delta i}{\Delta t}$$

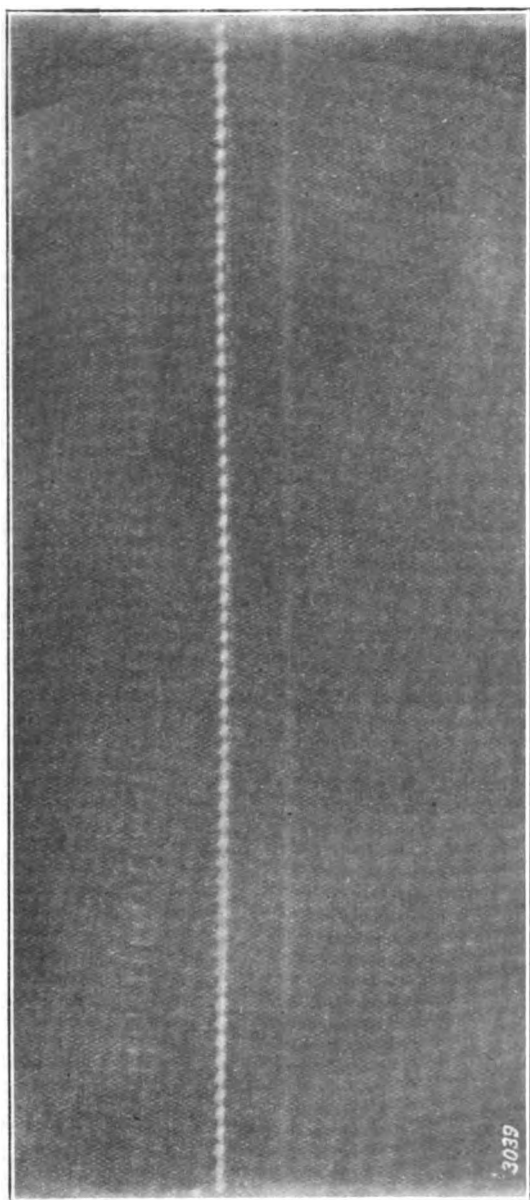
$$\text{whence } \Delta i = \frac{-i\Delta R}{R + L \frac{\Delta t}{\Delta i}}$$

That is, for a given change ΔR of the resistance of the circuit, the change Δi in current varies inversely as the value of the mean resistance and the self-induction of the circuit.

Hence, in an ordinary L.B. circuit, the magnitude of the primary current variations for a given variation of transmitter resistance will vary inversely as the primary impedance of the induction coil.

Therefore, if a line of high impedance is being compared with a line of low impedance, in switching over from the former to the latter, the sending end current will be doubly increased, first, on

account of the increased transformation ratio of current, and second, because the variations of the microphone current have also increased.



5.

Unfortunately, it does not appear possible to theoretically predict the change in the magnitude of the variations of the primary current due to a given change in the primary resistance, but the results of measurements made on this point are given below.

As previously stated, when two lines are being compared for transmission efficiency, the operator endeavours to speak uniformly throughout the tests. It was not convenient, nor was it thought likely to be accurate, to do this in the tests now to be described. A howler, of the type described in the POST OFFICE ELECTRICAL ENGINEERS' JOURNAL, Vol. 7, Part 4, was therefore taken and the connections re-arranged, so that the receiver and the microphone circuits were no longer interlinked.

Sinusoidal current of 800 frequency and constant value was then supplied to the receiver coils, the microphone being arranged in circuit as shown in 4.

The C.C. was supplied by two 2 v. accumulators and the 10⁶ non-inductive resistance was inserted to permit of the A.C. portion of the primary current being measured. The whole of the A.C. measurements, namely, the P.Ds. between 4-3, 3-2, 2-1, and 5-6 were made by means of the Franke machine in the usual manner. It will be observed, however, that even though the pure sine wave current is supplied to the receiver coils, it does not follow that the variations of the primary current will be simple harmonic. As a matter of fact, currents of other frequencies than 800 were fairly prominent both in the secondary and the primary. This point was further tested by taking an oscillogram of the current in the primary and from which it is clear that a sine wave of current in the receiver coils produces anything but a sine wave of current in the microphone circuit.

This being the case it only adds to the marvel that the carbon microphone transmits speech as well as it does. The conditions of the test were as follows, and the results are given in Table VI:

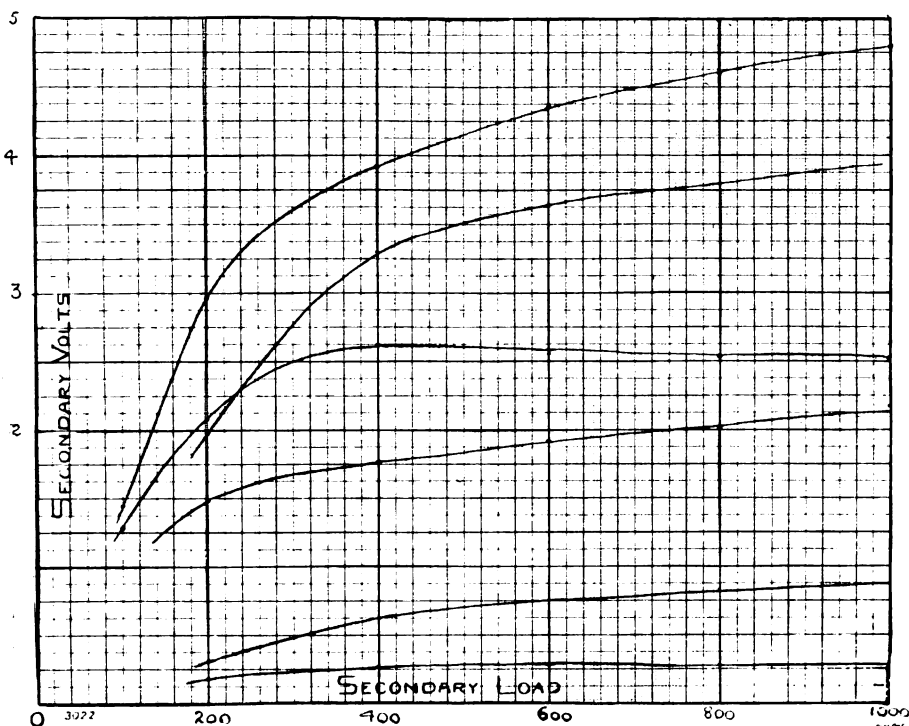
- (a) Current of constant magnitude and frequency = 800 v. supplied.
- (b) The secondary load which was non-inductive was varied from 0-2000 ohms.

TABLE VI.

Secondary load ohms.	Primary.		P.D. 3-4 volts.	P.D. 1-2 volts.	P.D. 5-6 volts.	Secondary current mas.
	C.C. mas.	A.C. mas.				
0	87.5	50.0	.912 157°	.441 50° 38'	0	—
100	80.5	43.5	1.268 150° 16'	.864 43° 38'	1.292	12.9
200	80.0	33.2	1.564 139° 6'	1.030 54° 41'	2.085	10.4
400	80.2	34.0	1.696 125° 34'	1.216 64° 0'	2.622	6.6
600	79.9	32.2	1.688 122° 46'	1.280 60° 56'	2.552	3.9
800	79.5	33.0	1.488 119° 4'	1.300 74° 30'	2.526	3.2
1000	79.9	32.0	1.480 117° 46'	1.296 75° 18'	2.520	2.5
2000	80.0	32.4	1.456 115° 30'	1.366 79° 24'	2.586	1.3

The angles shown are those by which the P.Ds. 3-4 and 1-2 lag and lead the primary A.C. respectively. In connection with the microphone it will be observed that the A.C. through it leads the alternating volts across it by an angle which varies between $115^{\circ} 30'$ and $157^{\circ} 0'$. That is, not only is the current considerably out of phase in this "non-inductive" resistance, but the angle of lead is greater than even that found in a condenser, viz. 90° .

The variation of the C.C. in the primary as the secondary load



6.

changes from 0 to 100^{ω} is not due to the gradual change in the state of the microphone and can be observed to instantaneously take place as the secondary load changes from 0 to 100^{ω} . The subsequent variations are thought to be experimental errors.

The most important point, however, about the test is the fact that the secondary voltage attains an approximate constant voltage as soon as the resistance of the secondary load becomes equal to 400 ohms.

If all L.B. induction coils behave in this way and give constant volts at the terminals of the secondary, irrespective of the line impedance, the usual formula for reflection loss with L.B. telephones

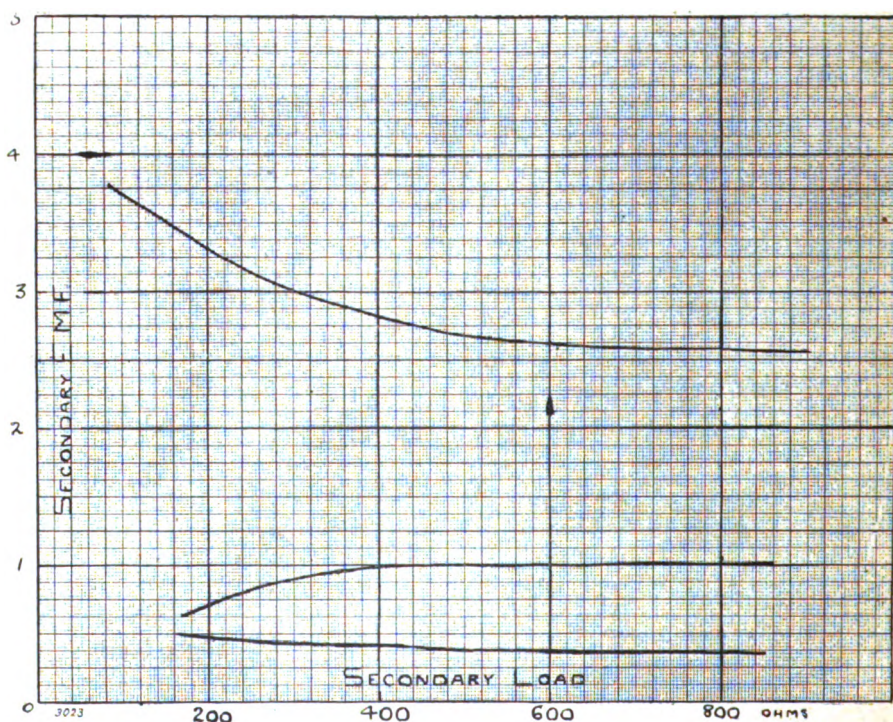
would have to be modified, since it assumes that an L.B. telephone generates a constant E.M.F. in the secondary, irrespective of the line impedance connected to it.

Thus, on the first assumption, the terminal loss—

$$9.43 \log_e \left| \frac{Z_o + Z_r}{Z_o^1 + Z_r} \right| M.S.C.$$

and on the second assumption it is—

$$\begin{aligned} & 9.43 \log_e \left| \frac{(Z_o + Z_r)^2 Z_o^1}{(Z_o^1 + Z_r)^2 Z_o} \right| M.S.C. \\ &= 2 \times 9.43 \log_e \left| \frac{(Z_o + Z_r) Z_o^1}{(Z_o^1 + Z_r) Z_o} \right| M.S.C. \end{aligned}$$



7.

Where Z_r = impedance of telephones used at sending and receiving ends,

And Z_o = characteristic impedance of standard cable,

And Z_o^1 = characteristic impedance of cable under test.

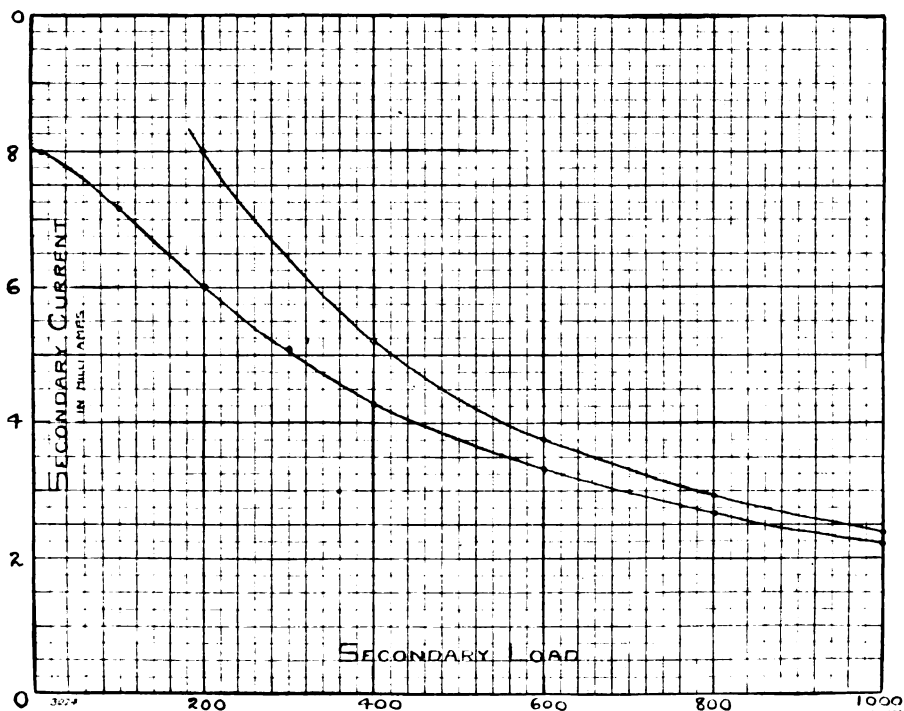
Hence it will be seen that the one assumption will give a very different terminal loss or gain as compared to the other.

The assumption as regards the sending end voltage is so fundamental that other coils were taken and also other values for the

current through the receiver coils to ascertain whether the previous test was in any way peculiar to that coil and those conditions.

The results of the further tests are shown by the curves given in 6. It will be seen that, although the secondary voltage is not so constant as in the first test, it still only rises gradually.

The next figure gives some of the corresponding curves for the E.M.F. generated in the secondary, and from which it will be seen that neither is this constant. It must, however, be borne in mind



8.

that there is a certain volt drop on the receiver itself which is in series with the line, and consequently the curves connecting line-voltage and line-impedance will be flatter than those given in 6.

It would seem, however, that it is not correct to assume either that the sending end voltage or that the generated E.M.F. in the secondary is constant, but rather that the truth lies somewhat between these two assumptions.

In conclusion, it would appear that as regards terminal loss with L.B. telephones only an empirical formula can be given, seeing that the value depends upon the particular telephones used in determining its value.

To the Editor of THE POST OFFICE ELECTRICAL ENGINEERS' JOURNAL.

DEAR SIR,—Mr. Murphy's article in your July, 1915, issue, entitled, "The Incompleteness of the Present Theory of Telephone Transmission," contains some prominent statements which appear to me to be calculated to produce an erroneous impression on an important point, and I shall therefore be glad if you can find space in your next issue for the following remarks on the subject.

The first paragraph of the article states that the commonly accepted law is that the received speech over lines in which the attenuation is the same is equal.

As there are a number of writers who state that such is not the case, this certainly is not a generally accepted law. In fact the more usual expression for the received current on a long line is as follows :

$$Ir = \frac{V \times 2 Z_0}{(Z_0 + Z_1)^2} \times e^{-\beta l}$$

Ir is the received current. V the impressed voltage (usually assumed to be constant), and Z_0 the characteristic impedance.

The apparatus Z_1 is supposed to be alike at both ends of the line. It may be seen from this expression that the received current must, by theory, be to some degree dependent on the impedance of the line and apparatus combined. Of course, in a large number of practical cases it is not necessary to take this specially into account, but in other cases (aërial loading for example) it cannot be neglected. Again, the expression I have given for the received current, does not quite agree with Mr. Murphy's mathematical deductions, inasmuch as he appears to ignore the impedance of the apparatus, and only to take that of the line into account. Now as the apparatus undeniably has impedance, it ought either to be taken into account or a definite reason given for neglecting it. Perhaps Mr. Murphy will deal with this point at a later stage.

Mr. Murphy himself gives prominence to the points I have raised and emphasises their importance, otherwise I should consider that the most important and useful part of his article is that which refers to the experimental exploration of the speaking apparatus. That is, I think, a very useful and desirable investigation, and I am looking forward with interest to the more complete information which Mr. Murphy has promised to give.

Yours faithfully,
J. G. HILL.

To the Editor of THE POST OFFICE ELECTRICAL ENGINEERS' JOURNAL.

DEAR SIR,—I have read Mr. Murphy's article on transmission with much interest, but I should be obliged if you could find space

for the following remarks. I am glad to see Mr. Murphy is again raising the question of the effect on transmission of the terminal apparatus, but I must contest the general trend of his article that it is a new and unknown effect. For many years it has been customary to use special transformers on loaded lines, to reduce the terminal losses, and in my paper, read before the Institution of Electrical Engineers in 1913, I showed it was quite possible to get appreciable losses on unloaded lines. A formula was also given showing the effect of the sending and receiving instruments on the transmission on a uniform line. Further, on account of the errors introduced by the terminals a new standard of transmission was proposed.

The whole matter is, to some extent, one of degree, but it would not appear to be the right line to adopt to ignore a loss simply because a greater one is present. For example, Mr. Murphy rather suggests that a 2 mile loss is negligible, being swamped by possible noises on the line, etc. Noise is a variable and indeterminate quantity, but whether it is present or not the 2 mile loss is still there, making that line so much the worse in all cases. Further, as time goes on, in all probability noise will be, to a greater and greater extent, overcome, and as heavier gauge, loaded and phantom circuits are brought more into use the variations in line impedance will increase and accentuate the terminal and transition effects.

Mr. Murphy mentions that, in my paper above referred to, I state the voltage on the line side of the repeater in a C.B. circuit is constant. He must have misread my paper, as the statement there is precisely the reverse of this. The *E.M.F.* generated in the instrument is practically constant for a given source of sound, but owing to the high impedance of the instrument the *P.D. on the terminals* varies.

Yours faithfully,

A. J. ALDRIDGE.

To the Editor of THE POST OFFICE ELECTRICAL ENGINEERS' JOURNAL.

DEAR SIR,—With reference to Messrs. Hill and Aldridge's letters, I would say first that I did not intend to convey the impression that terminal effects are new, but rather that, although they exist on paper, it is found in practice that they can be ignored when the few exceptional cases of very high impedance lines, like London-Leeds, nos. 6 and 7 trunk circuits, are excluded. Perhaps, therefore, in my first statement the word "rule" might better have been employed instead of "law." The object of the article was therefore to ascertain, if possible, why it was that in the majority of

cases, the terminal effects could be ignored and the simple βl rule employed.

With reference to Mr. Aldridge's work on the voltage available from a C.B. set, I agree I was in error in quoting it as showing that the P.D. at the terminals of the line side of the repeater is constant.

The question, however, as to whether the terminal P.D. or the generated E.M.F. is constant, is one which vitally effects the value of the terminal loss. So far my experiments have been confined to L.B. coils, and point rather to the terminal P.D. and not the generated E.M.F. being constant.

It seems quite probable, however, that neither one nor the other is actually constant, the result depending largely on the design of the induction coil. For instance, in a toroidal induction coil which I have made, neither the terminal P.D. or the generated E.M.F. is constant with different loads, but rather the output in watts from the secondary of the coil.

Yours faithfully,
F. MURPHY.

PERSONAL.

DR. MICHAEL IDVORSKY PUPIN, professor of electro-mechanics at the Columbia University, New York, was born on the southern frontier of Austria-Hungary in 1858. He is the inventor of the loading coil which bears his name and which has been such an important factor in the development of long distance telephony, resulting in "Coast to Coast" telephony in America.

Although born in Hungary, Dr. Pupin is of Servian ancestry. He came to America in 1874 when he was a little under 16 years of age. His first employment was as a "rubber" in a Turkish bath. After many vicissitudes he obtained a scholarship at Adelphi Academy, Brooklyn, and graduated from that institution. He entered the Columbia University in 1879 at the age of 21, and graduated at the head of his class in 1883 with the degree of Bachelor of Arts.

He then went to Europe, studying at Cambridge and Berlin, and later studying under Helmholtz, Bunsen and Kirchhoff. In 1889 he received the degree of Doctor of Philosophy from the University of Berlin.

In the same year he was appointed instructor in the Columbia University, New York, later being made full professor of electro-mechanics at that institution. In 1904 he received the degree of Doctor of Science from the Columbia University.

In 1895 Dr. Pupin began a series of experiments, and after a painstaking mathematical study his researches resulted in the inven-

tion of the famous Pupin loading coil which was publicly announced in 1901.

Dr. Pupin is a fellow of the American Society for the Advancement of Science, the New York Academy of Sciences, a member of the National Academy of Sciences, the American Philosophical Society, the American Physical Society, the American Mathematical Society, and the American Institute of Electrical Engineers.

He is honorary representative of the Servian Government in the United States, and at the present time is devoting all his time on behalf of his struggling countrymen.

Dr. Pupin is a splendid illustration of a man who seeks his opportunity and turns it to advantage.—*Telephony*.

A DESCRIPTIVE ACCOUNT OF CABLE DESIC- CATING OPERATIONS AT HALIFAX!

Extract from the 'Halifax Guardian.'

DIVING IN COMMERCIAL STREET.

ONE wonders how many people who pass along Commercial Street think of what is going on underneath. They read perhaps of diving in the sea, and marvel at what science can do in conveying air to the man working underneath fathoms of water. Yet the same thing was going on at the bottom of George Square this morning. There were the necessary apparatus, the two men turning a wheel around untiringly; another on the watch lest any breakdown should occur, and away underneath the man working and living on the compressed air forced down to him by the pump. And people passed by, caring little and seeing nothing. Yet we paused, and wondered what the worker's thoughts were, labouring away strenuously underneath one of the main business avenues of the town.

MAINTENANCE: LOCAL LINES AND INSTRUMENTS.

AN EXTRACT FROM A PAPER READ BEFORE THE NORTH-EASTERN CENTRE, INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS, AT LEEDS, BY W. D. SCUTT.

THIS paper is intended to be a study of maintenance (outside and inside), and refers to local lines and instruments as distinct from trunks and telegraphs. In the late National Telephone Company

the Traffic Contract Department, capital expenditure, transmissions, etc., were all highly organised, and results or records scientifically analysed and used to the best advantage. Maintenance was never studied to the same extent. It was mostly left to the local officers, who did what appeared best to them. I have seen the other main districts and noticed great variation in method, and yet I am of opinion that anything like a cast-iron uniformity in the various districts is to be deplored. Factors, such as type of area, staff, etc., should be considered. Besides, if all are alike, how can profitable comparisons of methods be made? The telephone stations at present in the service are approximately 753,000, and I should estimate the annual maintenance cost at £470,000 per annum; 1 per cent. of this = £4700; $\frac{1}{4}$ d. per station is nearly £1000.

I have no knowledge of the Head Office methods in regard to maintenance, but I think if some of this 1 per cent. were spent in a small head office department of men specialising on maintenance it would pay for their cost, and give more efficiency with greater economy. Probably this is done. I refer to the tackling of certain types of faults with a view to reduction. Now £470,000 as an annual charge of 10 per cent. gives a capital of £4,700,000. Expert and laborious study is given to the expenditure of such a capital sum, and should equally be given to maintenance. I trust my meaning is clear.

LINE MAINTENANCE.

Outside construction is a very important part of telephone engineering. It is very essential that the maintenance should always be kept to the front in dealing with new construction or re-arrangement. I think that a periodical analysis of line faults should be brought to the notice of the officers responsible for line construction. In this way they would see the predominating types of faults. It is always easy to add open wire circuits. Overhead plant is easily allowed to fall into a bad state, and possibly more than any other portion of the plant may absorb revenue in repairs, etc.

I have prepared several tables, on which the following appear interesting:

Table I, Col. 2.—It will be noticed that of the line faults the greatest percentage requiring more than one man are those on subscribers' premises, or in connection with fixings. The reason is obvious—difficulty in getting to trouble.

Referring to Col. 1, Table I, approximately 29 per cent. of line faults occur either on subscribers' premises or in connection with fixings on some property or other.

These figures refer solely to outside plant.

Table II.—A look at this is interesting. The greatest percentage

of line faults is due to broken wires. These figures may not be typical of a complete year, as they represent winter faults.

The next greatest is V.I.R. connections to open wire. A V.I.R. connection here means the point where a covered lead is jointed to a bare wire, the National Telephone method of connection.

The third highest is due to what I am calling "out of regulation."

GENERAL POINTS *RE* LINES.

Joints.—The old V.I.R. connection is a weak point, and it would seem that when the joint is exposed the covered lead should be of the same gauge as the open wire or of some special metal. The thin conductor loses its nature and weakens by corrosion, etc., before the bronze or copper wire. The present method of joining with lead-covered wire and the actual joint sealed up should rapidly eliminate this particular fault. Till then, we should periodically examine D.P. connections and renew them where defective.

Bare wire joints should also be abolished on fixings, if possible, and the bronze be continuous, as, although this fault is low in the list it is expensive, owing to difficulty of access and being an intermittent one usually.

Jointing Sleeves.—It is worth while drawing attention to the importance of men being impressed with the danger of careless use of these. It is easy to ruin the wire either at edge of sleeve or by overtensing a small length of wire. The instructions, I believe, say: Straight through joint, four complete twists for 40 lb. and 100 lb. wire.

Staying.—If a perfectly rigid distributing pole with a tremendous lateral strength of itself could be put up, the number of line faults would decrease. This, however, is not practicable, so that money spent in staying is well spent. New lines are so easily added one by one that the sum of the effects on the pole is easily lost sight of. So far as I can judge, however, we are greatly improving in this respect.

Renewal of Wire.—Probably a more systematic renewal of old and worn-out wires should be made, particularly in those cases where the atmospheric conditions are adverse. There will, of course, be a point where this pays in maintenance costs.

Subscribers' and D.P. Covered Leaders.—The P.O. lead leader will reduce this type of fault.

Improvements, recent (Leeds).—The percentage of faults on or about premises has improved considerably. I find that in relation to this, during the past year approximately 500 lines have been reduced in open mileage, due to interception by underground, and of these at least 160 lines have now no open wire, being covered distribution.

TELEPHONES LOCAL LINES AND INSTRUMENTS.

Covered Block Distribution.—It is a matter for question as to whether we have done enough of this. Be that as it may, however, I am not aware that we have reduced to facts and figures the merits and economy of covered against open distribution. There must in all cases be a critical point at which one or the other is the thing. In allowing a definite saving of annual charges due to the various factors, we cannot allow a value for improved service, lost calls, operating drags, etc. It is a pity that these cannot be equated into cash values. I have attempted a comparison, and although I cannot guarantee the figures I think they are fairly proportionate. (See Table IV.)

There is a further minor fact in favour of C.B.D.—*i.e.* we need not fit a protector or earth wire at an average value in place of 7s. 6d. each; a cheaper substitute for protector will do.

INSTRUMENT MAINTENANCE.

I have drawn up a table, No. III, giving the percentage of faults to instruments per annum. The items with the greatest number of faults come first in order of merit. The first item is automatic box faults, 10·06 per cent., again divided into three subheads—buzzer, chute, and registers. The next greatest item is cells, and the third, bells. These have been at the top of the list for some years.

It is worth noting that the following percentages are identical with the previous years, viz. bells, receivers, and night bell contacts.

GENERAL REMARKS.

Auto Coin Boxes.—The earlier boxes were too fragile. Consider the cost per annum, 1912, in maintenance. There were 1346 box faults (now reduced for 1914), or 3·04 per box. Assuming the cost per fault at 10d. each the yearly cost was 2s. 6d. A good deal more paid for better boxes would have shown itself economical if the faults could have been, say, halved.

Cells.—In view of coming C.B. these diminish in importance, but the best material is essential, as the cost of a cell fault will exceed the value of the porous pots.

Bells.—These appear a fruitful source of trouble, which is perhaps inevitable, owing to the motion and vibration.

The cost of clearing bell faults would appear to be about 3d. per station per annum. However, an average bell seems to hold good for nine years without failing, according to the figures. The present type does not seem to be the last word in a sound-producing article. Probably something in the nature of a piece of apparatus without moving parts will be designed.

Instrument Cords.—These are a very expensive item in instrument maintenance. However, a very good type is supplied at present. This is very important, as a few coppers' difference in buying a good class of cord is always less than the difference in costs incurred in changing: often the cost of changing exceeds the cost of the cord. The same remarks apply to porous pots and dry cells.

Class of Instruments.—Different types should be used for different premises. A special hard-wear instrument with no fancy part would be useful for stables, some railway offices, etc. This should be even more essential in automatic working.

Stores.—It is very important that these should be of the best class, and be thoroughly scrutinised and tested.

Reducing Faults.—As an example of what can be done by fighting a particular class of fault, in the three years prior to 1912 we reduced internal wiring troubles to 20 per cent. of what it was previously, by insisting on special attention to spirals and points where subscribers were tempted to "fiddle" with wires whilst talking.

GENERAL COSTS (LEEDS).

Line Repairs.—1907, 1908, 1909, and 1912: Averaged 6s. 6d. per line per annum (storms, etc., not included).

Instrument Repairs (including also Exchanges).—1907, 1908, 1909, and 1912: Averaged 7s. per annum per station.

Percentage of Wages to Total Cost.—Line repairs: 85 per cent. wages. Instrument repairs, 66 per cent. wages.

Traffic (Operating).—Approximately 6s. per station per annum.

Fitting.—Good instrument fitting is very important in regard to its effect on maintenance. It is surprising to work out the percentage of stations to total stations handled by fitters per annum. At the time I took a record (say four years ago) it was 20 per cent. approximately. The position of instrument accessibility, correct wiring, etc., are important.

Test Room.—This is a very important branch of a maintenance section. The tests should be above criticism, so as to keep the confidence of the faultsman. The records should be accurate. There should be a minimum of delay in obtaining the test clerk. Such delay is unproductive time, and in a large centre may be a serious leakage. Enough lines should be provided to ensure that "Test room engaged" rarely occurs. Besides his more obvious duties the test clerk should inform the chief maintenance inspector of the number of repeat faults, special faults, faults after routine visits, after fitters, and special delays. The supervision of repeat faults should be very keen. Probably a good use might be made of an additional column in lineman's diary, headed "Test," so that an

TELEPHONES LOCAL LINES AND INSTRUMENTS.

inspector would notice any serious difference in what a man was sent after and what he cleared.

ORGANISATION.

The tendency where an electrical section exists is to subdivide again into two main heads—maintenance and construction—these two being again subdivided according to local requirements and conditions. An efficient organisation is essential, but is only the framework upon which efficiency may be built, and the most elaborate tree will fail if the staff is not imbued with that enthusiasm and interest in its work which is so essential. I noticed in my inventory travels that the condition of the plant in some towns where no trace of an organisation appeared to exist bore favourable comparison with some of the more elaborate organisations where the staff tree seemed to have run to seed.

ROUTINE INSPECTORS, ETC.

Schedule of Faults Cleared or Prevented on Subscribers' Telephones during Maintenance Visits.

	Primary battery telephones.		Central battery telephones.	
A. Number of maintenance visits checked	1012		149	
B. Number of faults cleared or prevented	282		23	
C. Per cent. of faults cleared or prevented "A"	27'86		15'43	
<i>Type of Installation on which the Faults were Cleared or Prevented.</i>	No. of faults.	Per cent. of faults on type.	No. of faults.	Per cent. of faults on type.
Telephones, simple	132	25'3	8	10'5
Telephones on switch installations	79	28'7	7	17'5
Telephones on switchboard installations	71	32'9	9	24'2
<i>Apparatus on which the Faults were Cleared or Prevented.</i>				
Receivers	55		3	
Bells, magneto	58		8	
Bells, electric	12		—	
Cords (switchboard and instrument)	52		4	
Transmitters	27		—	
Hand Micro Telephones	2		—	
Switch hooks	21		2	
Indicators	12		2	
Wiring (internal)	9		3	
Switching apparatus	1		—	
Generators	33		1	
Totals	282		23	

With regard to these, in spite of the recent decision that one man shall take an area for both faults and routine visits, I cannot help retaining the opinion that routine inspection should in dense areas be done by one man and faults by another, because—

(a) The routine man can work steadily on, undisturbed by being sent elsewhere for faults.

(b) In any 10 or 20 men 50 per cent. are superior to the remainder, and faults would, therefore, be dealt with by the better man.

(c) The routine work is a good training for future faulters, and the faultsman keeps the routine man up to his work by objecting to scamped inspections.

SUB-EXCHANGES.

I think also that unless real waste in travelling would ensue, special men should deal with the larger of these. In this way you give a man a feeling of pride and possession, which tends to get the maximum efficiency from him.

FAULT CHARTS.

I think that it is a good thing to post up in view of the staff monthly comparisons of results in the way of faults, duration, etc. Differences in the constitution of the different faultsmen's areas, of course, affect the results, but my experience tells me that good resulted from these comparisons, as at least a man would take care not to show any deterioration, and in this way usually improved.

CHANGING CONDITIONS: EFFECT ON STAFF.

It is worth while noting that a curious change is taking place in the transferred staff. Whereas the Company probably encouraged to an extreme the practice of a man clearing a fault and repairing on a subscriber's premises, we are now to a greater extent changing the piece of apparatus. The C.B. apparatus accentuates this. The local mechanics' shop did every kind of repair, and the staff, even if they had not served in the shop, had every opportunity of going in and seeing apparatus actually under repair. I suppose the change would justify itself from an economic point of view, but I question whether the workmen will remain as efficient. Nothing educates so much as actual work.

TELEPHONES LOCAL LINES AND INSTRUMENTS.

TABLE I.

Location of line faults.	Percentage of total faults.	Percentage of faults requiring more than one man.
Pole to pole	41'4	2'02
D.P.	16'4	'47
Pole to fixing	14'1	2'03
Pole	8'8	'15
Fixing to fixing	7'52	1'79
Fixing	6'38	1'09
Underground	3'96	—
Subs.' leaders	'81	'07
Unknown	'47	—
Earth wires	'23	—
Total	100'00	7'62

TABLE II.

Type of line faults.	Percentages.				
	Total.	Dis.	Cont.	S.C.	Earth.
Broken wires	34'5	27'2	3'5	1'18	2'9
V.I.R. connections to open wires	20'4	20'4	—	—	—
Out of regulation	19'5	—	8'2	10'1	1'18
Caused by trees	5'5	'63	1'03	3'4	'47
Caused by gangs	3'8	1'8	1'03	'47	'55
V.I.R. leads on poles	3'24	3'	—	—	'24
Open wire connections	3'15	3'15	—	—	—
Caused by workmen	2'05	1'17	'24	'47	'16
Aerial cables (not lead covered)	1'65	'95	—	'31	'39
Underground cables	1'1	'39	'31	—	'39
Line fuses	1'02	1'02	—	—	—
House leaders	'95	'87	—	—	'08
Stay-wires and pole-earths	'71	'24	—	—	'47
Caused by jointers	'47	'39	'08	—	—
Caused by kite-tails	'39	—	'24	—	'16
Cable-head terminals	'31	'16	'16	—	—
Earth-wires	'31	'24	—	—	'08
Caused by broken fixings	'31	—	—	'24	'08
Total	100	61'5	14'7	16'1	7'1

TABLE III.

Type of instrument faults.	Percentage of faults to instruments per annum.
Auto boxes—Chutes	7.15
Buzzers	2.85
Registers	.06
	} 10.06
Cells	7.95
Bells	7.85
Instrument cords	7.65
Transmitters	7.64
Disconnected on instrument	4.96
Earpieces	4.44
Generators	3.82
Switchboard cords	3.49
Mouthpieces	3.39
Receivers	3.10
Faults due to subscriber	2.9
Miscellaneous	2.65
Switch-hooks	2.55
Faults on internal wiring	2.26
Cutout keys. H.M.T.	1.79
Indicators	1.61
Earth on instrument	1.47
Protectors	1.12
Switches	1.05
Short circuit on instrument	.87
Night-bell contacts	.86
Condensers	.085
Total	82.65

TABLE IV.

Class of plant.	Annual charges.			
	Depreciation, S.F. at $3\frac{1}{2}$ per cent.	Interest at $3\frac{1}{2}$ per cent.	Maintenance, ordinary, per cent.	Total, per cent.
Ground poles and fittings	3.6	3.5	1.9	9.0
Bronze wire, 40 lb.	5.2	3.5	7.3	16.0
Covered distribution	3.2	3.5	3.3	10.0
Insulators and brackets on premises	3.6	3.5	1.9	9.0

Covered Distribution.—From above table, total annual charges = 10 per cent.

TELEPHONES LOCAL LINES AND INSTRUMENTS.

Open Distribution.—These figures representing annual charges are based on the assumption that the various items are in proportion to the percentages shown.* The same annual charges have been given to “insulators and brackets” as are given to “ground poles and fittings.”

	Annual charges.			
	Depreciation, S.F. at $3\frac{1}{2}$ per cent.	Interest at $3\frac{1}{2}$ per cent.	Maintenance, ordinary per cent.	Total, per cent.
Open distribution, total .	4'02	3'5	3'684	11'208
Class of plant.	*Percentages.	Total per cent. annual charges.	Annual charges on expenditure of £100.	
Pole and fittings. . . .	28'1	9	2'53	
Distributing bronzes . . .	29'8	16	4'76	
Covered leads	12'3	10	1'23	
Insulators and brackets . .	29'8	9	2'68	
Total	100'0	—	11'20	

Therefore the annual charge on open distribution per £100 = £11'2.





THE SIMPLIFICATION OF LINE TESTING.

By GEO. F. TANNER, A.M.I.E.E.

THE following notes are contributed as it has been suggested they may possibly be of assistance to those engaged in the testing of telegraphic and other lines. In practical testing it is frequently necessary under ordinary conditions to alter the connections of the testing apparatus. To do this involves: (1) Technical skill; (2) A certain amount of wasted time. With regard to (1), it is not easy to go through the gamut of connections incidental to Varley's Loop Test. A mistake in one connection may be fatal. In any event, the time occupied in making the connections is precious, for telegraphic lines are constantly changing in value. The lineman at "the other end" is also liable to get impatient and "cut in" at the psychological moment. The piece of wire that is wanted is missing. A piece of odd scrap wire pressed into service is afterwards found to have a disconnection. All these things that *should* not happen *do* happen.

Where two results have to be associated in the same calculation, as, for instance, in arriving at the result of a loop test, the component tests, to contribute to an accurate result, must follow each other very quickly.

In the megger we have placed in our hands a machine capable of giving a rapid and reliable result to a test, and the writer, with a view to making it still more utilitarian, has contrived an arrangement whereby three tests can be given in a few seconds by simply operating one key-handle.

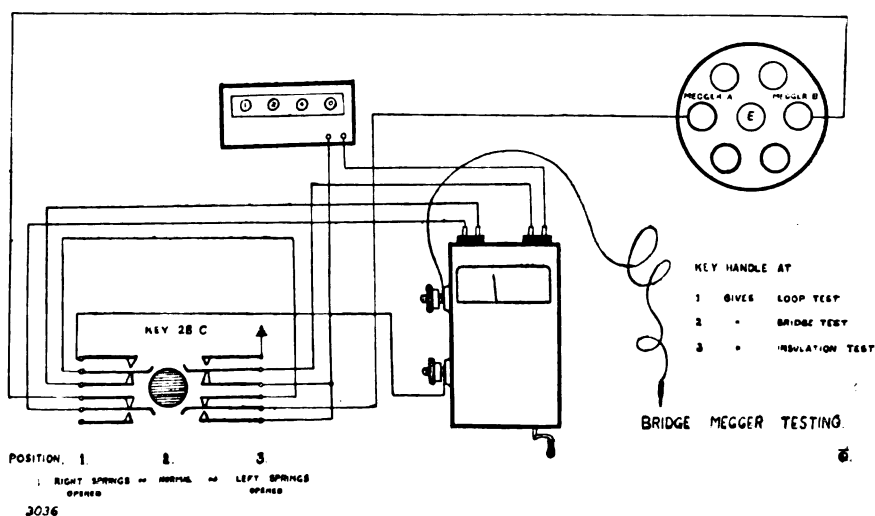
A key 28 C is connected, as shown in 1, and the method of making the tests is set forth in the following instructions issued locally to the testing staff. The flexible lead is used in making the insulation test, as, to avoid local loss, it is desirable to be able to apply the testing voltage direct to the spot required.

The arrangement has been working well at the C.T.O. basement, and is liked by those who use it. Its use involves little technical skill and produces accurate results.

With a view to rendering a satisfactory loop test on the ordinary Wheatstone Bridge set, "Post Office Box," the arrangement shown in 2 has been introduced with beneficial results. A copy of the local instructions is also appended.

BRIDGE MEGGER TESTING.

By means of the key switch three tests can be taken, viz.: (1) *Varley's Loop Test*; (2) *Conductor Resistance*; (3) *Insulation Resistance*, corresponding to three labelled positions of the key.



To obtain the *Insulation Resistance* of a conductor, disconnect at distant end and connect the megger flexible lead to home end. The switch on megger should be turned to "megger." The key should be turned to "insulation resistance" and "megger A" test hole linked to earth. On turning the handle of megger a direct reading in megohms will be obtained.

Conductor Resistance Test.—Turn key switch to appropriate position. Join loop to be tested to megger terminals on test tablet. If an earthed circuit, use a U link to earth A or B. Be sure that change-over switch on megger itself is placed to "bridge." If the ratio switch is placed at 1, a direct reading can be read on the bridge resistance box upon obtaining a balance. A balance is obtained when the index remains stationary at "G" on megger dial.

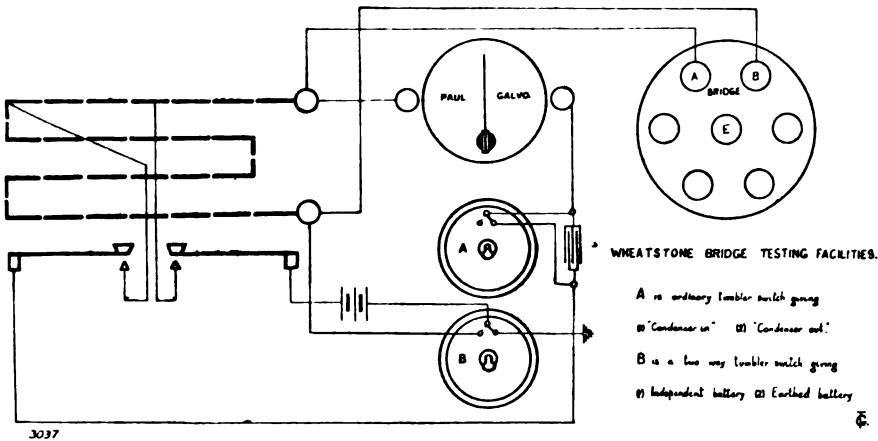
Varley's Loop Test. First.—Loop the distant ends of a faulty line

and a good one, and make the *Conductor Resistance Test*. Say result is 450 ohms. *Note* : The faulty wire should be joined to the "megger A" testhole on tablet, whilst the good one is joined to that marked "megger B."

Second.—Turn key to *Loop Test* and obtain fresh balance with unity ratio. Say result is 430 ohms, then distance of the fault in ohms is $\frac{450 - 430}{2} = 10$.

WHEATSTONE BRIDGE TESTING FACILITIES.

The bridge is arranged for readily taking the following tests: (1) Conductor Resistance; (2) Varley's Loop Test (to find distance of an



2.

earth fault expressed in ohms). To facilitate these tests two tumbler switches are provided. The function of the one is to furnish an *earthed*, or *independent*, battery as required. The other affords the means of switching a condenser across the arms of the bridge in series with the galvanometer for use when leakage currents are present.

To take (1) the *Conductor Resistance Test*, join loop across the "bridge" testholes on the test tablet. (For earthed single conductor link "bridge B" to earth.) Use unearthed battery, *i.e.* tumbler switch at "loop." Using equal values in the ratio arms of the bridge, say, 100 : 100, the resistance unplugged in the rheostat arm, D, of the bridge when balance is obtained is equal to the resistance under test. Should difficulty be experienced owing to the presence of a leakage current from line, switch the condenser $\frac{1}{4}$ mf. in across the arms. *Note*, however, that a balance is now obtained by permanently holding down the galvo. key and depressing intermittently

the battery key until no throw is obtained on the galvo. In the ordinary way the battery key is held down and the galvo. key depressed intermittently. The condenser method is not susceptible of extreme accuracy, but results can generally be relied upon to within about 2 per cent. If the current from line is very strong or fluctuating much use 10 : 10 ratio arms, as, in this case, the effect is reduced to a minimum.

To take (2) the *Loop Test*, get a good wire of any gauge and loop at distant end with faulty wire. Join wire (good one) to bridge testhole A and faulty wire to B on tablet. *First*, ascertain resistance of loop with loop battery as above. Say it is 450 ohms. *Second*, turn switch to earthed battery and rebalance. Say result is 430 ohms, then the distance of the fault in ohms is $\frac{450 - 430}{2} = 10$.

SCREENED CABLE CONDUCTORS AND THEIR APPLICATION IN TELEGRAPH SERVICE.*

By R. E. CHETWOOD,

Plant Engineer, the Western Union Telegraph Company, New York.

FOR a number of years it has been realised that the amount of cable which must be placed in important circuits of the railroad and telegraph companies would constantly increase regardless of all efforts to maintain these important circuits comparatively free of cable. City and municipal ordinances requiring the taking down of open wire construction and the replacement of it with underground conduit and cable construction is one reason for the increase in the amount of cable.

Another reason for an increase in the amount of cable in long distance circuits is that in the neighbourhood of large cities such as New York, Buffalo, Cleveland, Chicago, St. Louis, Kansas City, etc., it is becoming increasingly difficult to carry pole lines into and through these cities on account of congested railroad conditions.

For these reasons it was decided by the Western Union Telegraph Company a few years ago to make a complete investigation of the effects of cable on telegraph transmission, especially in connection with high-speed automatic systems of telegraphy, with a view to determining the most economical type of cable to be used in telegraph service.

At the outset of the investigation it was well known that the presence of cable in important high-speed circuits seriously reduced

* Abstract from paper read at the Annual Meeting of the Association of Railway Telegraph Superintendents, Rochester, N.Y., June 22nd.

their efficiency. It was known that the rubber insulated, and paper insulated cable that had been placed in circuits between New York and Chicago had gradually lowered the speed on these circuits. Records showed that the speed in cycles per second on circuits used in Wheatstone service between New York and Chicago had decreased from approximately seventy-five cycles in the year 1893 to thirty-five to forty cycles in the year 1910. This reduction in speed in a general way was known to be due to the high resistance and capacity of wires in cable compared with open wire construction and to the induction between telegraph circuits in the same cable when such circuits were used in high-speed automatic service. It was also known that where railroad telephone and train despatching circuits were carried in the same cable with high-speed automatic telegraph circuits there were disturbances of considerable magnitude induced on the telephone circuits. The railroad companies were gradually increasing their telephone facilities by the stringing of additional physical circuits and by the phantoming of existing physical circuits, and as, in general, it is economical to carry as many circuits as possible in one cable, it was most desirable that investigations be made to determine the type and character of cable which could be best used in general service.

The author then described the tests made to determine the effect of cable on telegraph circuits and to obtain data from which to design a type of toll cable that would most satisfactorily meet the requirements of the various telegraph and telephone services of the telegraph and railroad companies.

The results of these tests were thoroughly analysed and studied, and the following general conclusions drawn :

(1) Increasing the operating voltage approximately 40 per cent. only gives an increase in speed of approximately 10 per cent. when operating plain differential, and only 6 per cent. increase in speed when inductance and capacity is inserted at the apex of the circuit. By the application of inductance and capacity at the apex of the differential duplex a large percentage of the induction on adjacent telephone circuits in a cable can be eliminated when the telegraph voltage does not exceed 170 volts. The introduction of the capacity and inductance, however, decreases the speed at which the circuit can be operated telegraphically.

(2) Operating under the best conditions of apparatus and instrument adjustment and transmitting under like conditions, a commutator transmitter somewhat similar to the distributor used in the new Western Union multiplex will give a slightly higher average speed than that obtained with a Wheatstone transmitter.

(3) The substitution of No. 13 gauge conductors for No. 16 gauge conductors, or the substitution of No. 10 gauge conductors for

No. 13 gauge conductors, does not greatly increase the speed or telegraphic efficiency of the circuit. Under best conditions, replacing a No. 16 gauge cable conductor with a No. 13 gauge cable conductor increases the speed roughly 10 per cent., while the actual value of the cable conductor was approximately doubled. With circuits as ordinarily made up of open wire and cable, doubling the size of cable conductors will give still less increase in speed.

(4) The tests showed that most of the induction on the cable circuits due to telegraph operation is electrostatic and not electromagnetic, and the conclusion drawn from the tests was that approximately 90 per cent. of the induction was electrostatic and approximately 10 per cent. electromagnetic.

(5) The speed at which automatic circuits can be operated in a cable is considerably reduced unless special precautions are taken to minimise the effects of induction. In the length of cable under consideration, namely twenty-eight miles, the maximum speed of transmission would be reduced from 25 per cent. to 50 per cent., depending upon the number of other circuits operated and their relative location with respect to each other if special precautions were not taken to minimise the induction.

(6) Grounding one wire of a pair in the cable when the other wire was being used in high-speed service decreases the amount of interference to and from other circuits. In general, the amount of interference is decreased to the extent that a speed approximately 30 per cent. higher is obtained than otherwise would be the case.

From the results of these tests, together with data obtained from the British Post Office, it was decided that the proper type of cable for telegraph service, where high-speed automatic circuits were involved, would be to place a metallic wrapping around each pair rather than around each single conductor, and to take care of the induction between wires of a pair by means of an anti-induction device described later. This method would provide freedom from induction between wires composing a pair and between screened and unscreened pairs, and at the same time would decrease the cost of construction considerably. The screening of the pairs in this manner, of course, would also eliminate the induction on unscreened pairs in the cable which might be used for telephone service. Our calculations and tests showed that cable made in this manner could be used for phantom telephone circuits whether loaded or unloaded and for high-speed automatic circuits without serious effects from induction. The decrease in telegraphic efficiency of the circuits from causes other than interference due to induction, namely, due to the high resistance and capacity of cable conductors compared to open wires, would not, of course, be affected.

Tests made with the anti-induction device previously referred to

showed that the two wires in a screened pair could be used in high speed automatic service without mutual interference. This anti-induction device briefly consists of a condenser in series with a resistance and connected between the heads of the artificial lines of the duplex sets connected to the circuits. Its action is to induce on the local side of the differential relay in the duplex set a current equal to that in the line side of the relay due to induction along the wire. Since the magnetism in this relay is proportional to the difference of currents in the two sides, it is evident that the device practically neutralises the unbalance which would otherwise occur.

From the experience so far obtained with screened cable conductors in actual service, it appears that their use is the only practicable method of eliminating interference between wires in a cable when certain of the wires are used in high-speed automatic service, and the length of the cable is considerable. Where the length of cable is not very great, screened pairs are unnecessary and cannot be justified from a service or cost basis.

While the use of screened cable pairs will reduce the trouble due to mutual interference between circuits, still the effect of the high resistance and high capacity of cable conductors compared with open wires on pole lines is most detrimental to service, and this serious effect cannot be overcome by any reasonable increase in the size or gauge of the cable conductors.—*Telegraph and Telephone Age*.

WIRELESS TELEGRAPHY AND SUBMARINES.

CONSIDERABLE attention is at present focussed upon the activities of submarines, and the problems connected with their design and construction. Wireless telegraph apparatus is extensively installed on under-water craft, an aerial mast being erected when the vessel emerges on the surface. On first consideration it would seem a simple matter to arrange for this to be done, but it should be remembered that time is occupied in putting up and taking down such structures, and time is an extremely important consideration with the submarine commander. Many extremely interesting points concerning submarines are brought out in a paper by Lieut. C. N. Hinkamp, United States Navy, which recently appeared in the 'Journal of the American Society of Naval Engineers.'

It should be understood, says the writer, that there is nothing mysterious in the operation of a submarine. The orders used in the handling of the boat are few; they are made as comprehensive as possible and are so given as to eliminate any possible confusion. Preparing to submerge includes all preliminary work up to the closing

of the conning-tower hatch. This comprises the stowing of the deck gear, taking down the bridge, unrigging the wireless telegraph gear, closing the hatches, unlocking the valve-operating mechanism, securing the engines; in fact, a clearing ship for action. This operation requires from two to twenty minutes, depending upon the amount of rigging to be taken down.

The actual submerging of the boat can be done in two ways, one called the "static" dive, and the other the "running" dive. In the static dive, also known as "balancing," the boat is submerged but does not move except in the vertical plane. This dive may be accomplished in two ways: by trimming the boat and maintaining her trim by adjusting her ballast, or by dropping the anchor, trimming the boat to within a few hundred pounds positive buoyancy, and the heaving in or veering on the anchor cable. The latter way is the simpler method for easy control, and can be used where there is no current or only a small amount of current, if the sea is not too rough. Before submerging, the vessel is usually brought to a fore and aft trim, which will cause the boat to be level when submerged.

The running dive is made from the awash condition. In the awash condition the trimming tanks and auxiliary ballast tanks are flooded to the amount necessary for the proper trim when submerged; the main ballast tanks are empty. The running dive is used for all tactical purposes except balancing. The vessel being under way "awash," the order is given to submerge. All hands get into the boat, the engines are stopped, and the electric motors started. As soon as the engines are stopped the conning tower is closed, all ventilators housed, and the main ballast tank flooded. Knowledge that the trim will be approximately correct when totally submerged renders careful adjustment of ballast unnecessary. The boat is inclined slightly, about one half of a degree down by the head, and inrush of the water controlled by manipulation of the valves. All this is done in the short period of from one to two minutes.

Submerging a submarine is distinctly a "one-man" job. The commanding officer must be thoroughly conversant with all the details of the actual submerging of the boat, and he must at all times be thoroughly informed as to existing conditions in the boat. None of the important features can be delegated to anyone else, as each condition or state of affairs has a distinct relation to every other condition.

Signalling while submerged is a subject of much interest. In the early days of submarine navigation signalling under water was done in a most crude manner, for which the hull of a vessel was found to be peculiarly adapted. Sending was accomplished by tapping on a rivet with a hammer, and receiving by holding the forehead to a

frame of the boat. For several years inventors have investigated and experimented extensively, with the result that there are now in practical use in submarine signalling the submarine bell, the Fessenden oscillator, and the vibrating wire, by which it is possible to signal effectively at distances greater than five miles under favourable conditions. All these systems set up vibrations in the water, which are detected by microphones and heard through the ordinary telephone receiver. Inventors are now endeavouring to devise means for increasing the speed of transmission.

The primary object of a submarine is to fire torpedoes, and all other considerations must be subordinated to this as far as the tactical value of the vessel is concerned, but not to such an extent as to lose sight of the fact that the torpedoes cannot be fired at a target unless the vessel arrives on the scene of action. The efforts of the crew are aimed at one thing—sinking an enemy—and the placing of the boat in position to accomplish this end calls for the co-operation of all the departments in the boat.—*The Wireless World*, August, 1915.

LIEUT. GREELY AND HIS PATENT INSULATOR.

A GOOD story is told of the experiences of the late General A. W. Greely, at one time chief of the Signal Corps, U.S.A., with a patent telegraph insulator.

Lieutenant Greely—he was a plain lieutenant then—went to Texas in November, 1875, to build a telegraph line to San Antonio from Fort Brown. He had an insulator which he and other experts had gotten up in Washington especially for this line. It consisted of a well-lacquered sheet-iron cap over a dry wood screw and had the general appearance of a tomato can on the end of a broomstick, when in position.

The line was built 400 miles and for two weeks or a month worked like a dream. Suddenly warm weather set in, and when warm weather strikes lower Rio Grande it takes hold for keeps. The thermometer crawled up to 100, and after several weeks of this spell the line began to get mysterious kinks in it. There was trouble somewhere and plenty of it. The line was not down, but it seemed to have its grip on all through messages. San Antonio had to do all its business with Fort Brown by relaying at Laredo. In a few days Laredo could only telegraph as far as Ringgold Barracks, south, or to Fort Clark, north, and through messages from San Antonio to Fort Brown had to stop off three times *en route* and take a rest. At

the end of the week the trouble was worse, yet Lieut. Greely sent couriers galloping down the whole circuit. They could not find a place where the wire was down or in contact with trees or with anything else, but they reported something queer with the "insulators." Lieut. Greely was wild with indignant surprise. The idea of an insulator going wrong which had been concocted in Washington especially for Texas! Still the telegraph line was not working any better as a telegraph line than as a fish line or a clothes line, so he borrowed a mule from a quartermaster and started out to investigate. He came back in light marching order that evening with a sad secret in his heart, several lumps on his countenance, and minus the wayward army mule.

The simple truth was that the Texas hornets, which are lazy beasts, thought the new insulators were a shelter kindly provided by the Government for their special use, and had gone to work and filled every blessed one of them from San Antonio down with mud, sour honey and general cussedness, and the line was literally 400 miles of Hades in active eruption. Lieut. Greely wrote to Washington experts, who promptly got a new breed of insulators, solid as a brick and burglar proof. They were shipped and Lieut. Greely induced a gang of unsuspecting linemen to sign a cast-iron contract to take the old insulators off. The "repairing" party left Fort Brown on April 10th. By this time the hornets had raised an uproarious family in each insulator, and the first lineman who shinned up to serve the writ of ejectment got a dose of trouble that made his hair curl, and in his haste down let the pole slip up through his hands, burning them, besides taking all the buttons off his clothes. The way the hornets expressed their opinion of signal service hospitality was sinful. It cost the contractor forty-six able-bodied men, nineteen barrels of bread poultice, and a cask of refined arnica to "repair" the first eight miles, and operations ceased. When the linemen got so they could see well enough out of one eye to shoot they went gunning for Lieut. Greely, but he had already fled the State in a blue fog, and the next that was heard of him he had barricaded himself somewhere in the neighbourhood of the North Pole. The line remained in an active and warlike status until winter, and the telegrams were forwarded by the aid of a slow but persevering mule. After the first blizzard had calmed the hornet families into solid lumps the contractor resumed his labours, and recouped his loss by shipping the insulators to Baltimore for canning clams, and seven dozen crates of assorted stings to England for sale as sewing machine needles.—*Telegraph and Telephone Age*.

HOW TO ILLUSTRATE YOUR LECTURES AND ARTICLES.

By H. A. MILES.

MEMBERS of our Institution who require to illustrate their contributions to the various meetings or to the JOURNAL need to bear in mind several important factors.

Blocks or lantern slides may be prepared from line drawings or from photographs. Prints for the latter purpose should be from clean, sharp negatives, and on glossy P.O.P. bromide or gaslight paper. A bromide print is often used as a base on which to prepare a line drawing. The necessary photographic details are outlined and other work executed on the print with waterproof black ink, after which the photographic image is bleached out. This affords a simple method in cases where the complexity of the subject or the draughtsman's want of time or skill renders impracticable the preparation of an elaborate perspective drawing. The majority of illustrations are, however, prepared from line drawings in the usual way.

The preparation of a drawing necessitates the expenditure of a considerable amount of time and trouble, and unless proper care be taken initially the work may require altering, touching up, or re-drawing before it can be of use. I have therefore compiled a few hints which, coupled with the essential amount of technical skill in draughtsmanship, will, I hope, enable anyone to attain a satisfactory result. Artists, draughtsmen, and their near relatives, the authors, are from the first trained carefully to take a very one-sided view of things. Were they to forget this and decorate both sides of the paper, their work would in all probability go to swell the contents of the editorial waste-paper basket.

The material on which drawings for reproduction are prepared should be smooth and white—either “Turkey mill” paper or “Bristol board” will give the best results, but bluish (not yellow) tracing linen may be used if a tracing offers any great advantage over a drawing. Only the blackest of black inks should be employed, ordinary writing fluids being useless. Reeves’ “process black,” Higgins’ “American Indian ink,” or the ordinary “stick” Indian ink will be suitable, and neither will injure the drawing instruments. All drawings for reproduction should be prepared to an enlarged scale, but the breadth of the lines and size of lettering must be proportionately exaggerated so as to bear the subsequent reduction. If for use as lantern slides the greatest accuracy is needed on account of the pronounced magnification of the most trivial blemishes when displayed upon the screen, perhaps forty to fifty times full size.

ILLUSTRATIONS HOW TO ILLUSTRATE ARTICLES.

Illustrations intended solely for articles in the JOURNAL should preferably be drawn about twice the size they would probably appear, and if a scale is considered necessary it should be drawn, and not merely denoted in words—as regards lantern lectures, other conditions arise, and we have three distinct requirements to consider :

- (a) The lantern slide ;
- (b) Advance blue prints of the lantern slides for use by those taking part in the discussion ; and
- (c) Possible reproductions for illustrating a printed issue of the lecture.

We will first consider (a) and (b).

(a) The standard British lantern slide is $3\frac{1}{4}$ in. square (Americans also use quarter-plate, $3\frac{1}{4} \times 4\frac{1}{4}$ in.), but after allowing for masking and titling, the area available for use will be appreciably less than this.

(b) Blue prints of the illustrations for circulation with the mimeographed advance copies of the lecture should be foolscap size, 13×8 ins., and if they are numerous the simplest way will be to make a foolscap sepia (paper) negative from each group of eight slides *before the cover glasses are affixed*.

(c) Illustrations for the printed lecture are simply enlargements, to a suitable scale, from the lantern slide *negatives*.

The negatives, from which the slides are made by contact, are most economically arranged four on a half-plate—the full-size drawings being grouped and photographed simultaneously. There is thus a distinct advantage in having all the illustrations the same size, and 15×10 in. will, when reduced, give a lantern slide picture $1\frac{1}{8} \times 2\frac{3}{4}$ in. Of course, a separate quarter-plate may be used for each slide, if preferred.

In preparing the original drawings a firm border-line should indicate the boundary (15×10 in.), and the drawing itself should come to about half an inch inside this line. Of course, the illustrations may be arranged with the greater length either vertically or horizontally as desired, and as there is no rule without an exception, the size recommended may be departed from when unavoidable. Rigid adherence to the uniform size is less important in the case of articles for the JOURNAL, as they have not to be grouped for lantern slide making. A 15×10 in. drawing, reduced to $2\frac{3}{4} \times 1\frac{7}{8}$ in. on the negative for lantern slides, might be enlarged to form a full-page illustration, *i. e.*, about half of the size (linear) of the original drawing (half linear size is a quarter the area).

The art of drawing successfully for illustrations is one not easily acquired. Bold, striking effects, unfettered by a multiplicity of dotted lines representing hidden details, are best, and though shade lines are a distinct advantage if used judiciously, they can, if

employed unwisely, obscure rather than elucidate details. A good maxim is never to introduce an unnecessary line or to omit one which is needed. A careful study of the catalogues and other publications issued by certain of the leading engineering firms will prove very educative.

Letters and figures should be drawn neatly and accurately. The appearance of some of the best diagrams and drawings in the JOURNAL and printed papers has been more or less spoiled by careless lettering. Titles and reference letters are best kept upright, and in "block" characters. Explanatory notes, materials, and dimensions may be inserted in italics, sloped at $67\frac{1}{2}^{\circ}$ with the horizontal (see 2), though these examples are scarcely heavy enough. Plain lettering should be used exclusively, the eccentricities and flourishes affected by certain architectural draughtsmen are wholly out of place in engineering drawings. Good examples can be found in the Department's "Explanations of Symbols and Circuits on Plans," rubber-stamp catalogues, and in elementary books on mechanical drawings.

Connection diagrams or "circuits" present less difficulty than mechanical drawings, but here, also, a sense of proportion is needed to select the best thickness or breadth of line for various purposes, *e. g.* apparatus outlines, connections, mechanical details, etc.

I shows (A) part of a 15 × 10 inches drawing exactly as it should be drawn for practical purposes, (B) the lantern slide reduced from it, and (C) part of the block as enlarged from the lantern slide negative for the issue in the printed pamphlet.

I have looked through numerous printed papers by different members, and selected a few for comment and reference:

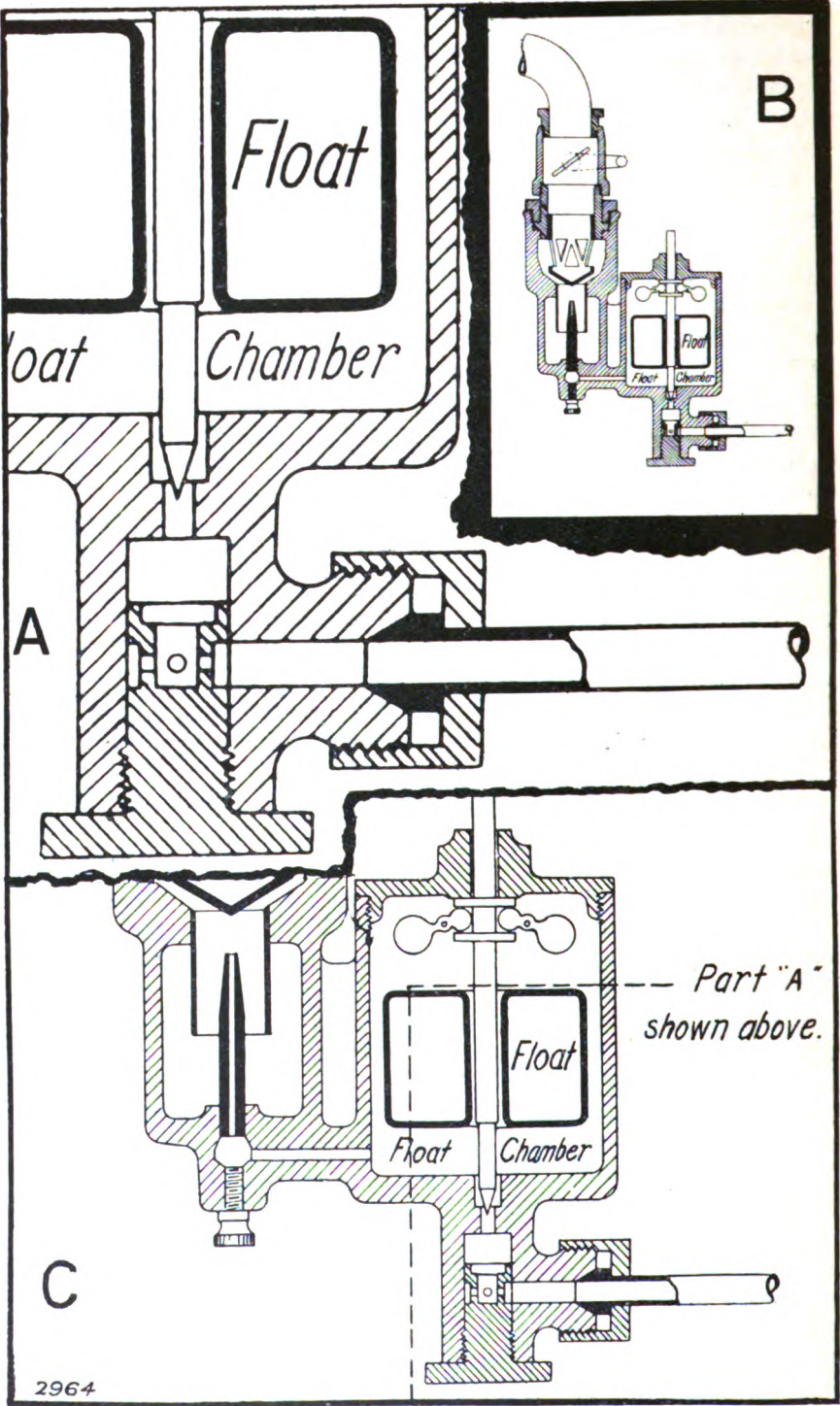
MODERN INTERNAL COMBUSTION ENGINES, by P. Dunsheath. Illustrations generally excellent, though lettering somewhat crude.

TELEPHONE TRANSMISSION, by J. G. Hill. Figs. 1, 3, 4, and 6 excellent; figs. 2 and 5 good, but not comparable with remainder, the B (waved) lines should always pass outside corners.

MECHANICAL CONVEYORS, by E. W. Pettit. The large size of the original illustrations presents a difficulty, and the detail in lantern slides would undoubtedly be too minute for reference except when projected upon the screen. The drawings are excellent, lettering clear generally, though in a few cases (*e. g.* figs. 19, 27, and 29) too small for the considerable reduction employed.

LOADING OF AERIAL LINES, by J. G. Hill. Illustrations (drawn) generally good, but in some cases scarcely bold enough (*e. g.* fig. 17), and the obsolete bridging of crossed, but unconnected, lines is employed in fig. 13.

SOUNDER SILENCERS, by J. J. Hardie (POST OFFICE ELECTRICAL ENGINEERS' JOURNAL, vol. ii, part 2, p. 124). Illustrations excellent, but instrument outlines in the diagrams should be more prominent.



ABCDEFGHIJKLMNOPQRSTUVWXYZ

ABCDEFGHIJKLMNOPQRSTUVWXYZ

abcdefghijklmnopqrstuvwxyz 1234567890

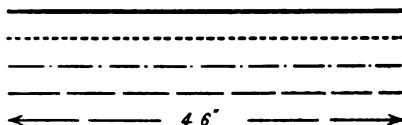
Construction or Visible boundary lines

Ditto hidden from view

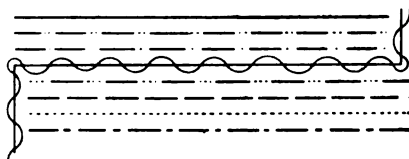
Centre line or pitch line

Projection lines

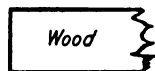
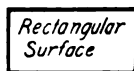
Dimension lines



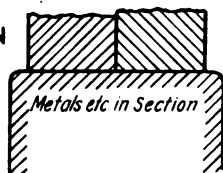
Indicating lines for use where Colours cannot be used e.g. in Circuits to be blueprinted, others may be devised if necessary.



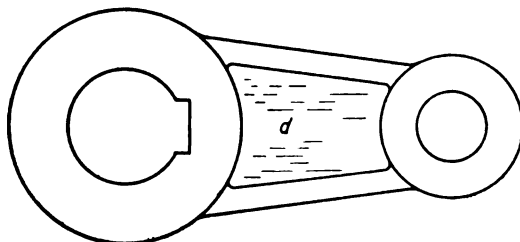
(A) BREAK LINES



(B) SECTION



(C)



Unless the portion (d) is 'Surfacelined' or a Section shown, the shape of the Casting is open to doubt.

TELEPHONE TRUNK SYSTEMS, by J. S. Brown. Diagrams too small to be legible.

As considerable difference of opinion exists regarding the use of drawing conventions, etc., a few of those recommended are shown in 2.

Circuit and apparatus conventions have been standardised for use in the British Post Office, and are now being lithographed; those for manual telephony and wireless telegraphy are already available.

BREAK LINES (*A*, 2) are employed where it is impracticable or unnecessary to show the entire length of a detail.

SECTIONS (*B*, 2).—Metals and other materials in section may be indicated by parallel lines at 45° , the spacing of the lines will vary according to the size of the detail, and very large areas may be section lined around their boundaries only. Adjacent pieces of material should be lined in opposite directions, or if more than two meet the lines should “break joint.” Thin sections to a small scale, such as frequently occur in engine details, girder sections, etc., are very effective if filled in black (see examples in Mr. Dunsheath’s paper referred to elsewhere). It is sometimes desirable to differentiate between wood, metal, ebonite, etc., in which case wood may be grained and ebonite, or other insulator, ruled with very close horizontal lines, or, in the case of very small details, filled in black. I do not advocate elaboration and variety in section lining; it is far safer to rely upon a specification, schedule of material, or a printed indication against the item in question. There is absolutely no uniformity of practice, and various firms use identical conventions for different purposes.

I know of drawings so unskillfully prepared that it is almost impossible to distinguish between surfaces and spaces, full (not broken) dimension and projection lines, the same thickness as the construction lines, being, to a considerable extent, responsible for the muddle. The use of broken dimension and construction lines, and a very little additional work in the way of “surface lining” (*d*, 2), would have prevented any misconception and added very considerably to the appearance of the drawing.

Wood should have the grain indicated lightly; metal and other material may, *if necessary*, have a few short lines drawn preferably in the direction of its length; glass should be shaded diagonally to give the appearance of a reflecting surface.

The limitations imposed by the title of this article preclude any detailed exposition of the art of mechanical drawing, but I hope that the few hints I have been able to give will be found useful to authors and illustrators, and that the editors and publishers will also benefit by the avoidance of the unnecessary trouble and expense they have in many instances experienced hitherto.



EDITORIAL NOTES AND COMMENTS.

SOME time ago we were asked by Mr. E. S. L. Hase, of the Bristol Telegraph Office, for the correct solution of a seemingly simple problem, viz., what is the capacity of the condenser in the compensation circuit of a double current duplex necessary to balance a line of given capacity? In practice, of course, the telegraphist in charge of the circuit balances for capacity by checking his adjustments on the galvanometer and relay or receiver, and a skilled man has not much difficulty in securing a good working balance, provided that the electrical characteristics of the line are not varying to any great extent. Theoretically, the problem is far from being a simple one.

The conditions in the differential duplex are as follows :

(1) Both keys at rest. Batteries at the two stations in series on the line. At the down station + to line.

(2) One key depressed. Batteries in opposition on the line, the depression of the key reversing the battery at the sending station.

(3) Both keys depressed. Both batteries reversed from the condition in (1), but still in series on the line.

(4) The conditions when one or both keys momentarily disconnect the battery circuits in crossing from "space" to "mark" and *vice versa*. On a duplex circuit the keys are adjusted to "break" momentarily before "making."

The passage of the quantities from and to the line and compensation circuits must be balanced in the two windings of the relay, in order that no interference with the working signals may be

experienced. It is many years since Mr. H. R. Kempe gave us the mathematical proof that when a battery is connected to a line, the distant end being earthed, and the battery then removed and the home end of the line earthed, two-thirds of the charge will go to earth at the home end and one-third at the distant end, but this proof does not cover entirely the conditions demanded in duplex. In practice it is found that the capacity required in the compensation circuit to give a balance is approximately one-third of the static capacity of the line. Mr. Morice, of the Engineer-in-Chief's Research Section, has given us in the following letter the results of an investigation he has made into the subject. They may be summarised as follows: If the capacity of the line be taken as a lumped capacity in the centre, the capacity in the compensation circuit to secure a balance is equal to one-fourth that of the line. This value has to be made larger and larger as the line capacity is made more distributed until the limit of one-third is reached in the case of a line the capacity of which is uniform throughout its length, which is usually the condition met with in practice. It must be admitted, as Mr. Morice says, that the analysis is not complete—for instance, no allowance is made for the effects of the retardation coils (non-inductive) in series with the condenser in the compensation circuit on long lines—but we make no apology for its publication now. So far as we are aware, no other attempt has been made to interpret mathematically and experimentally the complex problem of the simple duplex, and we are indebted to Mr. Morice for his painstaking labours.

The Editor, POST OFFICE ELECTRICAL ENGINEERS' JOURNAL.

With reference to the question raised by Mr. E. S. L. Hase, I submit herewith an approximate solution. It should be pointed out that this solution is not intended as a complete mathematical analysis of the problem, as such an analysis would involve the expenditure of a great deal more time than is at present at my disposal. Perhaps I may be able to make a more extended solution of the problem at a future date.

Referring to Fig. 1—

Let C = capacity of the line per unit length.

„ L = length of the line.

„ x = distance from the sending end of the line to any point on that line.

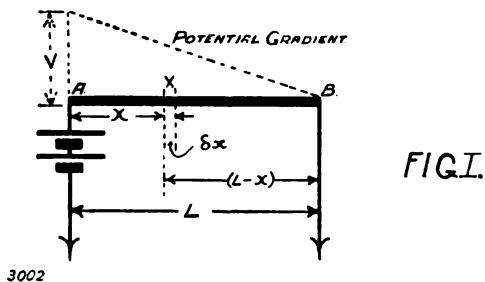
„ R = total resistance of the line.

Suppose that the potential at one end of the line is V and that the other end is earthed.

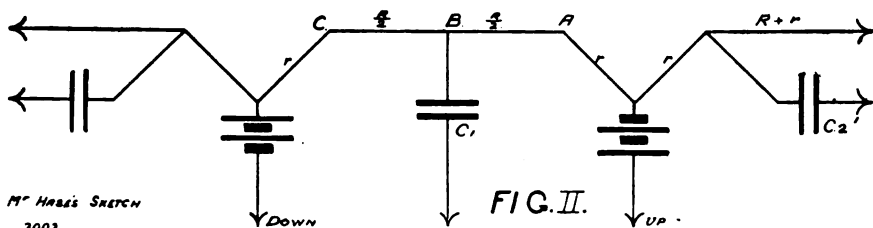
Then potential at $X = \frac{V(L - x)}{L}$

and quantity of electricity on element δx at $x = V\left(\frac{L-x}{L}\right)C \cdot \delta x$.

If the voltage is suddenly removed, the quantity of electricity discharged at A due to the quantity on the small length δx is $V\left(\frac{L-x}{L}\right)C \cdot \delta x \left(\frac{L-x}{L}\right)$ or $V.C. \delta x \left(\frac{L-x}{L}\right)^2$, since the quantities flowing from x to A and from x to B will be inversely proportional to the resistances of the lengths xA and xB .



1.—SIMPLE TELEGRAPH CIRCUIT EARTHED AT DISTANT END.



2.—DUPLEX TELEGRAPH CIRCUIT AS GIVEN IN MR. HASE'S PAPER.

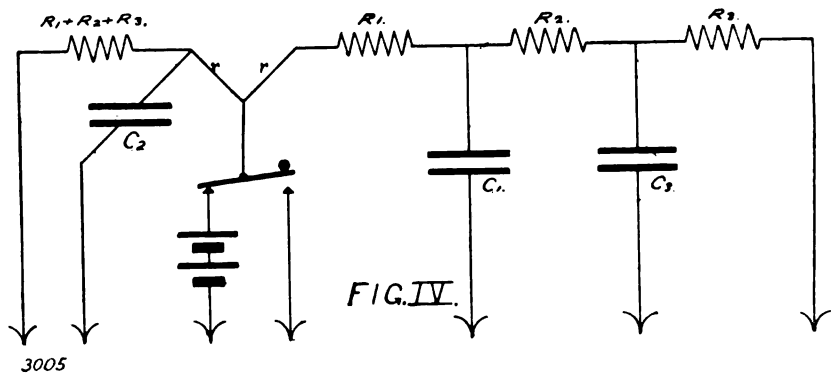
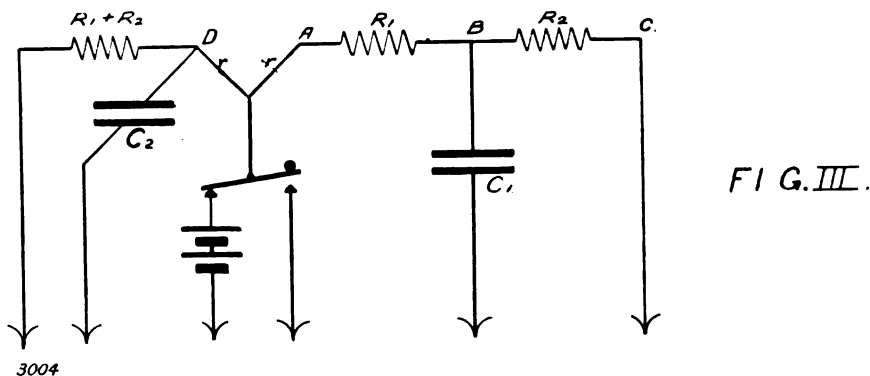
Hence the total quantity flowing away at A

$$\begin{aligned}
 &= \int_{x=0}^{x=L} \frac{V.C.(L-x)^2}{L^2} dx \\
 &= \frac{V.C.}{L^2} \int_{x=0}^{x=L} (L-x)^2 dx \\
 &= \frac{V.C.}{L^2} \int_{x=0}^{x=L} (L^2 - 2Lx + x^2) dx \\
 &= \frac{V.C.}{L^2} \left(L^2x - Lx^2 + \frac{x^3}{3} \right)_{x=0}^{x=L} \\
 &= \frac{V.C.}{L^2} \left(L^3 - L^3 + \frac{L^3}{3} \right) = \frac{V.C.L.}{3} = \frac{V.C_1}{3} \quad \dots \dots \dots (1)
 \end{aligned}$$

where C_1 = total capacity of the line.

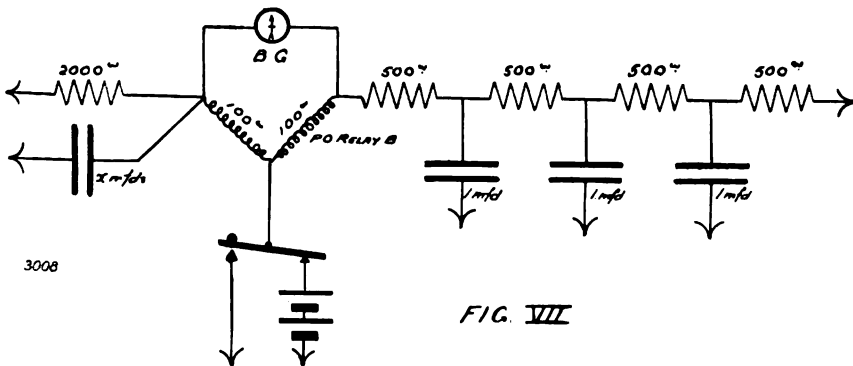
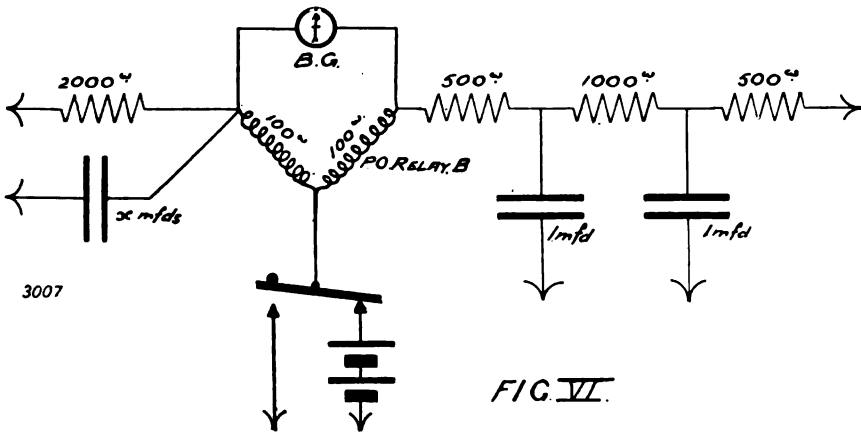
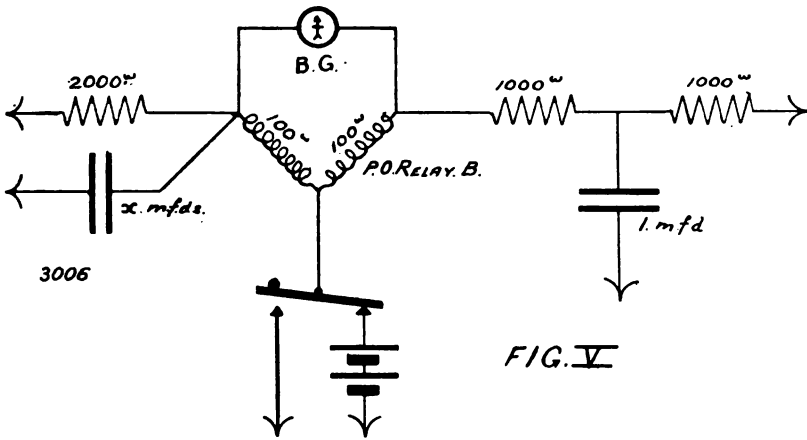
Hence if V is removed, the other end of the line being earthed, a capacity discharge results at end A , which is equal to $\frac{1}{3}$ rd the capacity of the line multiplied by the potential V .

Now in Figs. 2 and 3 of Mr. Hase's paper, depressing the key changes the potential at the up station by the amount $2V$ (if V is the battery potential), the potential at the other end of the line being



3 AND 4.—THEORETICAL DUPLEX TELEGRAPH CIRCUITS.

unaltered. Also the line is earthed at the down station. Hence if the line capacity is uniformly distributed the resultant quantity flowing through the line coil of the up station relay (from the previous proof) is $\frac{2VC_1}{3}$, where C_1 is the total capacity of the line. If C_2 is the capacity of the condenser in the up compensation circuit, then the quantity flowing through the compensation coil of the up station relay is $2VC_2$. Now for balance of the quantities of electricity flowing in



5, 6, AND 7.—COMPENSATION CAPACITY FOR DUPLEX CIRCUIT. DIAGRAMS OF CONNECTIONS USED IN EXPERIMENTS (a).

the up station relay, we have (neglecting the effect of the relay coils)

$$\frac{2}{3} VC_1 = 2 VC_2$$

$$C_2 = \frac{1}{3} C_1 \quad (1a)$$

If the capacity of the line be assumed as in Mr. Hase's sketch, viz., a lump capacity in the middle of the line (see Fig. II), then the potential change at B , due to the depression of the up station key, will be equal to V .

Hence $\frac{VC_1}{2}$ will be the resultant quantity flowing through the line coil of the up station relay.

Hence for balance—

$$\frac{VC_1}{2} = 2 VC_2 \left(\frac{R+r}{R+2r} \right)^2 \text{ where } r = \text{Resistance of one relay coil.}$$

$$\therefore C_2^1 = \frac{1}{4} C_1 \left(\frac{R+2r}{R+r} \right)^2 \quad (2)$$

If the resistance of the relay coils is neglected—

$$\text{then } C_2^1 = \frac{1}{4} C_1.$$

If r is small compared with R —

$$\text{than } C_2^1 = \frac{1}{4} C_1 \left(1 + \frac{2r}{R+r} \right) \text{ approximately.}$$

Before proceeding to give experimental figures in support of the theoretical results (1), (1a), and (2), it will be well to consider how the compensation capacity for a duplex telegraph circuit may be calculated, so as to give a quantity balance in the relay coils. Consider Fig. III in which the line is represented by two resistances R_1 and R_2 and a lump capacity C_1 . The change in voltage of B , due to a depression of the key, is equal to $V \left(\frac{R_2}{R_1 + R_2 + r} \right)$. The quantity which flows through the line relay coil due to this change of voltage is $V \left(\frac{R_2}{R_1 + R_2 + r} \right) \left(\frac{R_2}{R_1 + R_2 + r} \right) C_1$. The quantity which flows through the compensation coil of the relay due to a depression of the key is $V \left(\frac{R_1 + R_2}{R_1 + R_2 + r} \right)^2 C_2$.

For balance—

$$C_2 \left(\frac{R_1 + R_2}{R_1 + R_2 + r} \right)^2 = C_1 \frac{R_2^2}{(R_1 + R_2 + r)^2}$$

$$C_2 = C_1 \frac{R_2^2}{(R_1 + R_2)^2} \quad (3)$$

Similarly, considering Fig. IV, the condition for balance is—

$$C_2 = \frac{C_1 (R_2 + R_3)^2 + C_3 R_3^2}{(R_1 + R_2 + R_3)^2} \quad (4)$$

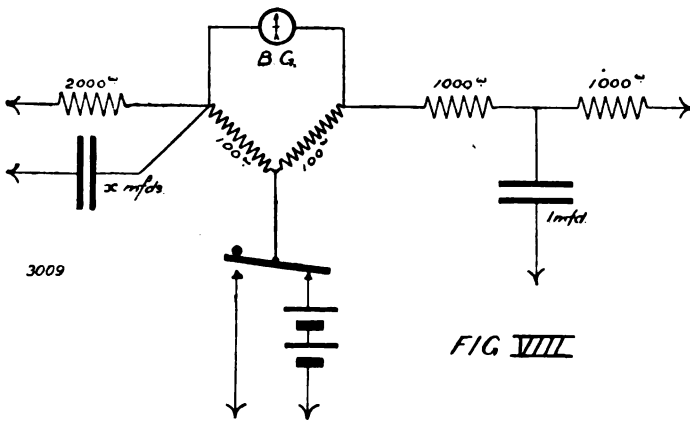


FIG. VIII

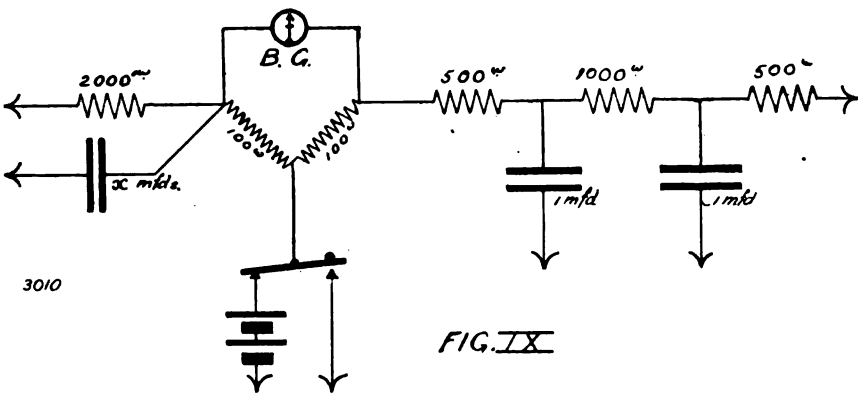


FIG. IX

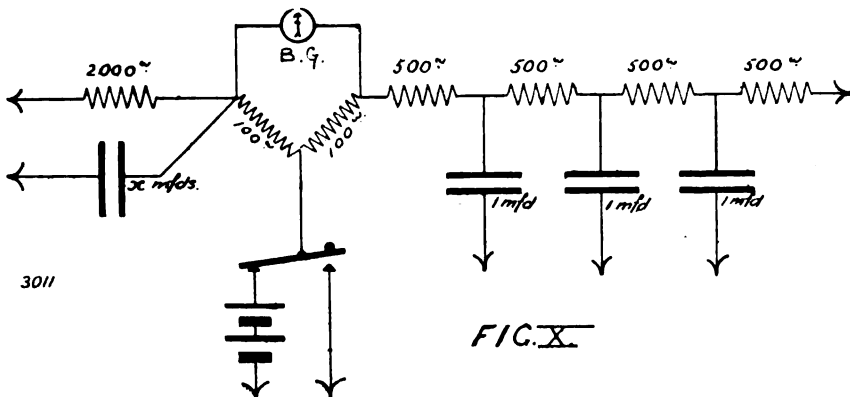


FIG. X

8, 9, and 10.—COMPENSATION CAPACITY FOR DUPLEX CIRCUIT. DIAGRAMS OF CONNECTIONS USED IN EXPERIMENTS (b).

A similar equation could obviously be written down which would give the compensation capacity required for a line made up of combinations of capacity and resistance other than those shown in Figs. II, III, and IV.

In either Fig. II, III, or IV the time constants of the line and compensation circuits will not be equal, but formulæ (2), (3), and (4) will give the compensation capacity required in order that a depression of the key may result in equal quantities of current flowing through the relay coils.

The following experiments have been made in order to prove the foregoing theoretical deductions.

(a) Experiments with Sullivan ballistic galvanometer bridged across relay coils :

Reference figure No.	α Microfarads.		Percentage difference between experimental and theoretical values of α .
	Theoretical value.	Experimental value.	
*V	0.250	0.235	- 6.0
VI	0.625	0.630	+ 0.80
VII	0.875	0.885	+ 1.14

(b) Experiments with Sullivan ballistic galvanometer bridged across 100-ohm non-reactive ratio arms :

Reference figure No.	α Microfarads.		Percentage difference between experimental and theoretical values of α .
	Theoretical value.	Experimental value.	
*VIII	0.250	0.235	- 6.0
IX	0.625	0.618	- 1.12
X	0.875	0.873	- 0.23

* These figures are only approximately correct for want of sensitivity in the apparatus used.

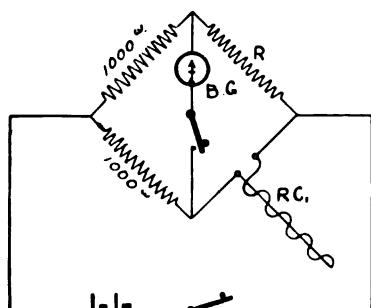
(c) Experiments with ballistic galvanometer, measuring the throw obtained both with standard cable and with a capacity shunted by resistance :

FIGS. XI AND XII.

Length of cable.	Resistance in ohms R .	Capacity in mfd. C_1 .	Capacity C_2 in mfd.	Throw with connections as in Fig. XI.	Throw with connections as in Fig. XII.
30 S.M.	2532	2.05	0.683	95	94.5
50 S.M.	4209	3.36	1.120	192	192

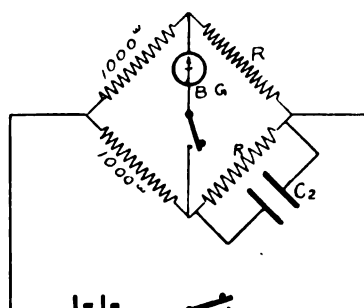
These experimental results support the theoretical results, Formula (1), in which the compensation capacity is shown to be

one-third of the capacity of the line for balance of quantities, the latter capacity being uniformly distributed.



3012

FIG. XI



3013

FIG. XII

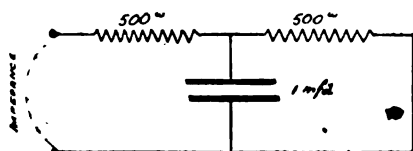
II AND I2.—COMPENSATION CAPACITY FOR DUPLEX CIRCUIT. DIAGRAMS OF CONNECTIONS USED IN EXPERIMENTS (c).

(d) Measurement of impedance using the Franke machine, and A.C. current of frequency n such that $2\pi n = 3000$:

FIGS. XIII AND XIV.—*Impedance in Vector Ohms.*

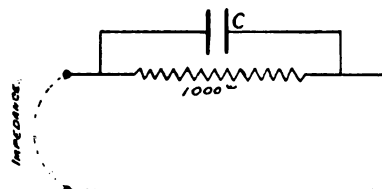
Connections as in Fig. XIII.	Connections as in Fig. XIV with C equal to		
	0.2 mfd.	0.3 mfd.	0.4 mfd.
$1180 \angle 6^\circ 31'$	$1400 \angle 45^\circ 31'$	$1086 \angle 57^\circ 2'$	$878 \angle 64^\circ 1'$

If a curve is plotted, using values of C as abscissæ and the moduli of the impedances as ordinates, it will be found that the modulus of the impedance (connections as in Fig. XIV) is equal to 1180 when $C = 0.25$ mfd.



3014

FIG. XIII



3015

FIG. XIV

I3 AND I4.—COMPENSATION CAPACITY FOR DUPLEX CIRCUIT. DIAGRAMS OF CONNECTIONS USED IN EXPERIMENTS (d).

In conclusion, the answer to Mr. Hase's question is that the compensation capacity, under the conditions of circuit which he

describes, must be approximately one quarter of the line capacity in order to give a balance of the D.C. duplex circuit. Also the compensation capacity in a duplex telegraph circuit can be obtained by summing up CR^2 (where C is the line capacity at any point and R the resistance of the line between that point and the distant end) and dividing the value obtained by the square of the compensation resistance.

A. B. MORICE, B.Sc.,

August 17th, 1915.

Research Section.

A SIGNAL-MASTER ON ACTIVE SERVICE.*

THE following letter from Lieutenant W. J. Gwilliam, R.E., addressed to the Managing Editor of the JOURNAL, will be read with interest and pleasure by his many friends in the Home Service.

Before joining His Majesty's forces Lieutenant Gwilliam was stationed at Reading as Executive Engineer in the South Midland Engineering District.

DEAR CRUICKSHANK,—

I hear you are well and very busy with the paste and scissors. I am fit, but only moderately busy. The strenuous life in a Section during the last few years makes it somewhat difficult to settle down under the existing military conditions. My daily duty as signal-master averages eight hours, and when it is over it is possible—owing to the present deadlock—not only to forget that there is a war, but also to forget the work. The latter is still a novelty to me, but I do not think it makes me any happier.

The signal-master is responsible for the military telegraphic and telephonic traffic, the maintenance of the lines and apparatus, and the disposal of despatches by despatch riders. In addition, he performs odd jobs which range from the fitting of electric bells and the care of the electric light plant to the inspection of latrines and charge of the Headquarter Company's horses.

The cable and air line construction is hardly worth its name.

The risks are not exceptional. When fighting is in progress, the enemy will shell the advanced Headquarter Signal Office if he can locate it. When there is no fighting, visits are sometimes made by hostile aeroplanes and bombs dropped. On the last occasion this occurred, eight bombs were dropped, which resulted in the death of a harmless hen and the hasty termination of my breakfast.

When I first came out ten months ago things were fairly lively. After reporting, I eventually joined the Corps at Ypres. No doubt you have already read that this famous Belgium town was not particularly healthy during last October and early November.

* Passed by Press Censor.

However, in spite of shells and Taubes nothing happened to me, but I was not sorry when the remnants of the — Corps were ordered south after the Germans had given up the offensive.

Sir John French has given a fair description of the work done by the — Corps at Ypres during this period, and if you read it you will learn that out of approximately 20,000 men about 3000 were left with very few officers. Reinforcements and an additional division joined us from England, and we finally came to rest south of Ypres, in a dirty French town and on the banks of a still dirtier river. We remained in this dismal spot throughout the winter and on till June, and during this period the battles of Neuve Chappelle, Aubers, and Festubert were fought.

I understand that the censor has allowed to be published a complete and truthful account of all that occurred at these battles. You therefore know all about the operations.

On each occasion I served as signal-master on a twenty-four hour relief at the advanced headquarters of the Corps. These are the only times when I have really earned my pay.

Modern warfare is beyond the imagination unless you are actually on the spot, and even then there is not a great deal to see unless one can view the battle from an observation post. The noise from the guns is incessant, like one continuous roll of thunder lasting for several hours. It gradually dies down, and then the infantry are launched for the attack. The prolonged shelling is for the purpose of smashing and battering down all obstacles, such as barbed wire entanglements, fortified barns, and farm-houses, etc. Sometimes it is successful, frequently it is only fairly successful, hence the importance of high explosives in unlimited quantities. You will easily understand that considerable responsibility rests with the signal-master during such fights. The messages dealt with are of the greatest importance. They consist of technical messages.

Whilst the fighting is in progress, communications have to be maintained between the divisions, brigades, battalions, and also artillery. This is where the construction officer earns his pay. The enemy endeavours to destroy all telegraphic communications and also prevent the advance of all reinforcements. His artillery, therefore, shell all roads and fields in rear of the firing line. Repairs to wires are in consequence carried out at considerable risk.

A problem yet to be solved is a satisfactory method of keeping up communication between troops who have captured trenches and the directing force in rear. An infantryman cannot cross the fire zone and take part in an attack on an enemy's trench, carrying a coil of wire in one hand, a telephone in the other, and a rifle and bayonet between his teeth. It is also impossible to cross after the trench has been captured owing to the terrible fire from machine guns. Visual

signalling appears to be the only practical method at present, but it is hardly satisfactory.

I am not looking forward to wintering here again, but I am afraid there is no other prospect. Last winter was a severe strain, but we were in comfort compared with the troops in the trenches, who lived with icy cold water up to their thighs for periods of twenty-four hours.

During the early months of the year I gave numerous lectures on Telegraphy and Telephony at the Headquarters and Brigade Signal Offices. The arrangements at the brigades were somewhat primitive. The lectures were given in ruined and battered villages, in barns and cellars, accompanied by noises outside of a somewhat disturbing nature. However, I usually enjoyed the outing, which sometimes included an invitation to dine with the Brigadier-General and a further invitation to walk round the trenches after dinner. I always accepted the former, but never the latter.

Just now I am living under comfortable conditions. From my bedroom window I have an excellent view of the fireworks each night. Motor ambulances carrying the wounded pass at all hours and in the early morning or before the dusk. It is interesting to watch the shelling of German aeroplanes by our anti-aircraft section. Few bulls are made, but generally the Taubes are either driven back or prevented from "spotting" important positions.

The British Post Office has been of very great assistance in providing the Army here with telephone equipment and air line stores. Pole brackets and insulators, small, have saved the situation on several occasions when the Army type of insulator has not been obtainable; 40 lb. bronze and iron wire are also frequently used in place of the three-strand silicon bronze wire, which is the standard wire for Army air lines.

Buried cables do not escape damage. A message from "mother" or "grandmother" will make a mess of things, even of buried cable. You may be interested to know that I recommended the use of some Post Office rubber-covered twin leading-in cable for use under water. The open wires were frequently carried away by barge masts. Eight wires were laid as a submarine cable. The circuits worked well for three months, and the cables were good on recovery.

Drakes, an old Post Office man whom you may remember, and who is now Assistant Engineer-in-chief, South Africa, writes me that the Engineer-in-chief is Director of Army Signals with the South African Forces. South Africa has always been a progressive colony.

Well, I have no further news just now. Remember me to old acquaintances.

Yours faithfully,

W. J. GWILLIAM, Lieut., R.E.

POST OFFICE ENGINEERS' V.T.C. TRAINING CAMP, WHITE HILL, CATERHAM, JULY 17th-25th, 1915.

THE Post Office Engineering Corps, under Commandant Gunton, has always aimed high, so that while orders respecting the projected co-operation of the Corps with the Signal Troop of the 1st South-Western Mounted Brigade at Forest Row camp gave great satisfaction they caused no surprise. It was a disappointment, therefore, to hear that these arrangements had been unavoidably cancelled, and falling back on the formation of our own camp was thought to be only "making the best of a poor job." That such a view was mistaken the sequel will show.

An advance party of about twenty N.C.O.s and men had the experience of preparing the camp under Company Commander Harvey Smith assisted by Half-Company Commander Edmonds. The members of the advance party (who thoroughly enjoyed their "experience") would suspect sarcasm if the word pleasure had been employed. Tents are such awkward things to handle in a storm!

Quartermaster Parsons, with a cheery heart and an enthusiastic staff, had taken possession of a considerable tract of territory, which they designated a "camp kitchen." The result of the united efforts of these parties was that when the main body, under the guidance of the Commandant (who had spent the morning in reconnoitring and in interviewing local magnates for the peculiarly Post Office engineer's business of "wayleaves"), marched on to the ground soon after 5 p.m., they found a real camp, complete; although, as a mounted force, they naturally missed the "horse lines"!

The camp looked very workman-like, and everyone soon settled down and tried to appear an old soldier.

Sunday is a good day to begin camp life. Church parade with a march to Caterham Church with the Royal Naval Air Service, and a short march to reconnoitre the terrain proposed for the air-line operations, constituted the duties of the day; apart, of course, from the routine duties of the camp. An aviator or two took an interest in our encampment, and the weather favoured all cheerful social life. No doubt a second Sunday in camp would have been different in respect of widening of interests if a longer stay had been possible; as it was, "breaking camp" was the actual business of the second Sunday. This, while an interesting, is not an exhilarating function. But that belongs to the end of the story!

The Commandant's efforts had secured the interest of a local landowner—Mr. Parkhouse—who gave facilities for our technical

operations over an ideal tract of country. The extreme value of this was brought home to us on one day when joint field operations with the Naval Air Service were seriously hampered by the cantankerous attitude in an adjacent area of a farmer who sported the proficiency badge of the Volunteer Association! The route, White Hill to Hill Top Farm cross-roads, will live in the memories alike of those who got their clothes wet through *from* the skin and *to* the skin according to the heat and the rain!

On the Wednesday we marched, by invitation, to Marden Park to co-operate with the officers and N.C.O.s (many of them direct from the Front) who were training and being trained there in grenade throwing. The route was through hilly country, and the march,



I.— CATERHAM CAMP. A GROUP OF OFFICERS.

though short, was distinctly a test of the “grit” and stamina of the men, especially of those who carried the heavy kit. We provided telephone circuits in the trenches and between the umpires, and our efforts were so much appreciated that we were asked to go on the Friday night for further operations. For that occasion the R.N.A.S. provided a motor lorry to take the whole party, including Colonel Warden, the officer commanding the “Architects” V.T.C., who was a guest of the officers on that evening. The Commandant’s pioneering faculty on that cross-country drive was faultless on the outward journey; and one little slip on the return enabled him to get us back to camp exactly at midnight as promised, instead of a little in advance of our time-table.

Colonel Sir Edward Raban, K.C.B., having seen the Corps’ work at Marden Park, honoured the camp with a visit on the Friday

morning ; and although the heavy rain (combined with the fact that most of the men were in mufti owing to the drenching they got the day before) prevented him from seeing any air-line operations, he was obviously much interested in the appliances that he inspected. The practical results of this interest have yet to develop, but their promising character may be inferred from the fact that already Major-General R. M. Ruck, C.B., R.E., Chief Engineer of the Central Force, has inspected the Corps and its work. He was accompanied by Lord Desborough as well as by Sir Edward Raban.

Probably before this, readers who attended the camp will be saying—"What about the Royal Naval Air Service?" Well, I am



2.—CATERHAM CAMP. A GROUP OF N.C.O.s AND SAPPERS.

half afraid to open this subject lest I should seem to be writing a note on the R.N.A.S. in mistake for the P.O.E.V.T.C.!

Indeed, if Lieutenant Richard C. M. Pink, R.N., had been in charge of our camp he could not have helped more enthusiastically ; and his officers, petty officers, and men seconded his efforts to the utmost. Lieutenant Pink provided the site of the camp, and he placed such numberless facilities at our disposal that we really had to be careful not to indicate any new need lest it should be promptly met ! Someone was always just going into Caterham when we wanted something brought up ; we had a car for any emergency, a lorry for all our operations ; we could telephone, swim, or take baths. One of the C.P.O.s supplied the Commandant with a "charger." If there was anything at "The Mound" that

we wanted it was at our service to any possible extent. They even provided us with a field-day, working out a scheme which ended in a retirement before strong enemy forces which only just failed to outflank and capture our telegraph equipment.

I hope the light strain of these notes does not convey the impression that there was no hard work done. There was a lot; and the discipline, the self-help, the experience in keeping fit in a crowded tent and in pouring rain, were all good for "soldiering." But we did not omit the play part. "You are going to have the time of your lives" shouted the outgoing party to the incoming party at the station on Wednesday night. I wonder if those men thought of that the next day when they returned soaked from air-line operations, and some of them volunteered to improve the stores tent trenching, working in breeches and boots only!

We had the luxury of a piano hired from Croydon, and produced an excellent concert one night, which was attended by all at "The Mound" who were off duty. Some of the naval men very acceptably helped the programme. On another evening the whole camp was invited to "The Mound" for a concert and responded with a practical unanimity that was amply justified by the event. The officers also exchanged social courtesies. Incidentally, on our side, this enabled our Quartermaster to display his exceptional abilities in catering.

In all, eleven officers and ninety-nine N.C.O.s and sappers attended the Camp. After Church Parade on Sunday, July 25th, we struck Camp—quite a strenuous operation—and just before 5 p.m. the detachment was dismissed at Caterham Station to entrain for the journey home.

The concluding paragraph of a restrained and comprehensive Record issued by Commandant Gunton may suitably adorn the end of these rough notes. He said:

"I desire to express my keen appreciation of the work done and of the good discipline and *esprit de corps* maintained, almost without exception, throughout the week's training. Those members of the Corps who attended this camp have not only largely increased their experience and improved their efficiency, but may feel that they have materially helped to bring the objects of the Corps to the notice of officers of the Regular Forces, with the result that the useful work of the Corps is likely to be extended in the immediate future."

The Report includes a complete list of the names of all who attended.

A. J. S.

HEADQUARTERS NOTES.

RECENT DEVELOPMENTS OF THE BAUDOT DUPLEX.

BAUDOT duplex experiments between London and Paris were first commenced in the summer of 1914, but were postponed on account of other urgent matters. The preliminary success of the double duplex on the Dieppe cable ensured that the experiments would be continued at the earliest convenient period, which did not occur until June, 1915.

Two double duplex installations were fitted to two of the circuits passing through the 6-wire cable between Beachy Head and Dieppe, with very satisfactory results, during the month of June, and now a combined triple or double duplex set with two distributors has been fitted for working over the shorter cable routes *via* Calais and Boulogne.

Up to the time of writing the working of the triple duplex set has given no trouble, so far as the duplex arrangement is concerned, but the real test of its value in increasing the number of channels by 50 per cent. on the shorter cables will occur during the approaching winter months, when the long land lines suffer from insulation loss and other disturbances.

In neither case do the double or triple duplex installations represent the limit of the capabilities of these cables, but for practical reasons it is probable that quadruple duplex on the shorter cables and triple duplex on the larger cables will not be attempted at present.

BAUDOT DUPLEX CIRCUITS.

Inland.

London-Birmingham	.	Sextuple duplex.
" "	.	" "
" Glasgow	.	Quadruple.
" "	.	" "
" Liverpool	.	Quintuple.
" Brighton	.	"

Continental.

London-Berlin	.	.	Double duplex	} Suspended.
" "	.	.	" "	
" "	.	.	Double and triple	
" Hamburg	.	.	Double duplex	
" "	.	.	Double and triple	
" Emden	.	.	Double	
" Antwerp	.	.	Double and triple	
" Paris	.	.	Double duplex.	
" "	.	.	" "	
" "	.	.	Double and triple.	

AUTOMATIC EXCHANGE DEVELOPMENT.

July 7th, 1915.—Chepstow Automatic Exchange equipped for 65 lines opened.

In this exchange the Chepstow subscribers dial the Newport (Mon.) exchange operator direct for trunk calls. The Newport operators also dial the Chepstow subscribers from the manual board.

Automatic communication is also provided between Chepstow subscribers and the Lydney trunk and local exchange operator.

August 9th, 1915.—Paddington Traffic Distributor for 1000 lines brought into use. The subscribers' lines are being transferred to this equipment gradually.

August 14th, 1915.—Newport Automatic Exchange equipped for 2000 lines opened.

This exchange replaces four manual exchanges, and 1424 subscribers were transferred therefrom as follows :

From Newport Ex. National	. . .	1060 lines.
„ „ P.O. Ex.	. . .	150 „
„ Maundee	. . .	210 „
„ Malpas	. . .	4 „

Facilities are provided at nine sub. exchanges in the Newport area for dialling the Newport automatic subscribers direct.

MANUAL EXCHANGES.

CONTRACTS have been placed for extending the existing equipment at :

Edgbaston new exchange . . . 880 lines.

Dublin Junction equipment.

Installation has been commenced at :

Dover new exchange . . . 700 lines.

Merthyr Tydvil new exchange . . . 310 „

Woking new exchange . . . 600 „

Hampstead extension . . . 1080 „

Lee Green . . . 200 „

Installation of the following equipment has been completed :

Darwen new exchange . . . 520 lines.

Belfast conversion from single to double clear . . .

Chiswick extension . . . 1100 „

Hammersmith extension . . . 1100 „

Sale extension . . . 120 „

Sevenoaks extension . . . 100 „

Streatham extension . . . 600 „

Wimbledon extension . . . 1200 „

COUNCIL NOTES.

A MEETING of the Council was held in London on July 8th; Mr. A. J. Stubbs presided.

The question of delay arising in connection with the printing of papers submitted by the local centres and approved by the Council was discussed, and it was resolved to remind local secretaries that papers should be submitted within two months of the date on which they are read. It was recognised that occasionally the author of a paper desired to amplify points which arose out of, or were suggested by the discussion following the reading of the paper, and in some cases to provide fuller details which would render the paper when printed more valuable. In other cases in which rough notes were used as the basis of a lecture, much time was lost in writing up the same in a form suitable for printing. The Council undertook to expedite the consideration of papers as far as possible, but must, of course, rely on the local committees to co-operate in the same direction.

The following Committees, etc., were appointed for the current year:

Board of Editors (Council Representatives).—Chairman: Mr. T. F. Purves. Members: Messrs. J. W. Atkinson and W. T. Harris. Managing Editor: Mr. W. Cruickshank.

Library Committee.—Chairman: Mr. J. W. Atkinson. Members: Messrs. J. A. Hunt, W. Dolton, W. T. Harris, T. Smerdon.

Librarian.—Mr. J. Smerdon.

Editing Committee.—(5 members): (Chairman of Council and Secretary, *ex-officio*), Messrs. T. F. Purves, A. W. Martin, J. W. Atkinson, E. S. Cohen, E. H. Shaughnessy.

T. SMERDON.

Secretary.

MAJOR W. A. J. O'MEARA, C.M.G., R.E.

The following announcement appeared in the 'London Gazette' dated September 3rd, 1915:

General Staff.

General Staff Officer, 2nd Grade.

Major Walter A. J. O'Meara, C.M.G.,

Reserve of Officers. Dated August 19th, 1915.

Major O'Meara resumed military duties at the outbreak of war, and for twelve months has been stationed at Chatham, where, *inter alia*, he has had charge of the Royal Engineers' Institute. His contributions to the 'Royal Engineers' Journal' (particularly the issues of July and August, 1915) have not passed unnoticed. Indeed, his

interesting abridgment of a study of the strategical relations of France and Germany during the years immediately preceding the present war has attracted much attention.

It will be remembered that Major O'Meara saw active service in the Burmese War of 1885 (where he received eleven wounds, and for his services was mentioned in despatches and was awarded the Frontier Medal with clasp and a wound pension), and in the South African War (where he was senior officer on Colonel Kekewich's staff, and in that connection and for other services was mentioned in despatches and received the C.M.G. and medal with five clasps). In April, 1902, Major O'Meara became Assistant Engineer-in-Chief at the Post Office, and in March, 1907, was promoted Engineer-in-Chief, a position which he relinquished on February 28th, 1912. A *resumé* of Major O'Meara's activities both in the Army and in the Civil Service was furnished in our issue of April, 1912. On the eve of his jubilee (January 28th, 1913) Major O'Meara was called to the Bar, and thus entered his third profession, but, as already indicated, his career in this field of service was abruptly interrupted by the call to arms of August, 1914.

Major O'Meara's many friends and admirers will continue to watch with interest the career of this distinguished and versatile public servant.

LONDON DISTRICT NOTES.

NEW BUILDINGS IN PROGRESS.

London District Headquarters, Denman Street, London Bridge.—Only slow progress is now being made with this building owing to the difficulty in obtaining men and materials.

There is nothing special to report in connection with the other buildings now in progress referred to in our last issue.

EXCHANGE EXTENSIONS.

Hammersmith.—The extension of the equipment by 1120 lines, 258 junctions and the modification of 6 junction positions to keyless order wire has been completed.

Willesden.—The extension of the equipment by 700 lines and the modification of 10 junction positions to keyless order wire is in hand.

Chiswick.—The extension of the equipment by 1120 lines and 140 junctions is now completed.

Putney.—An extension of the Common Battery No. 1 switchboard at Putney has been completed, bringing the fitted multiple capacity up to 4000 subscribers' lines, and the incoming junctions have been converted to keyless ringing.

Paddington.—The conversion of 20 junction positions to keyless working has now been completed.

Work in connection with the experimental automatic traffic distributor is proceeding, and some 300 lines out of the proposed 1000 have already been brought into use.

NEW TELEPHONE LINES.

During the thirteen weeks ended July 27th, 1915, 3331 exchange lines, 2878 internal extensions and 281 external extensions were provided. In the same period 3572 exchange lines, 1863 internal extensions, 195 external extensions were recovered, making a net decrease of 241 exchange lines and a net increase of 1015 internal extensions and 86 external extensions. It will be noted that the process of reducing the number of lines and increasing the number of stations, remarked upon in previous issues as having occurred since the outbreak of the war, steadily continues.

Transfers.—During the half-year period ending August 14th 2521 subscribers' lines were transferred from one exchange to another with a view to improving transmission conditions and eliminating the abnormal conditions existing prior to the amalgamation of the two London systems. The process of rearranging lines has been a continuous one since the transfer of the National Company's undertaking to the State, but it will now be suspended until the end of the War. Some 20,000 lines have been transferred in this manner, and a very considerable improvement in the subscribers' service has thus been brought about.

EXTERNAL CONSTRUCTION.

For the three months ended July, 1915, the net increase in telephone exchange wire mileage of the London Engineering District was 20,882 miles, the increase under the heads of open (bare wire), and underground, being 83 and 21,224 miles respectively, whilst open (aerial cable) decreased by 425 miles.

Telephone trunk wire mileage increased by 461 miles; telegraphs increased by 9 miles.

Pole line increased by	.	.	.	12 miles
------------------------	---	---	---	----------

Pipe	„	„	.	41 „
------	---	---	---	------

The aggregate mileages in the district at the end of July, 1915, under the various services were as follows :

Line Milcage.

Pole line (bare wire)	.	.	.	2479 miles.
-----------------------	---	---	---	-------------

Pipe line	.	.	.	3447 „
-----------	---	---	---	--------

Single Wire Mileage.

Telegraphs . . .	21,469	} Inclusive of spare wires, exclusive of Post Office wires on railways, maintained by railway com- panies.
Telephone exchange .	979,272	
Telephone trunks .	30,732	

The total length of cables is now 7061 miles.

C.T.O. SECTION.

The original $1\frac{1}{4}$ inch Creed air-pressure main has now been replaced by one of $2\frac{1}{2}$ inch bore. The new main has been run from the container in the basement to the first, second, and third floors; and already the majority of the seventeen outlets provided have been allocated to Creed sets.

St. James' Street B.O.—A set of house tubes has been installed in this office and, being of brass, are of an ornamental character. The motor-pump has been fitted in a cellar away from the main building, and all noise and vibration in the office has thereby been avoided.

Hatton Garden B.O.—The above office was removed recently, and this involved cutting the existing street tube in Hatton Garden and extending it to the new office. The office fittings were installed well in advance of the date of removal, and a stoppage of only a few hours was involved, in order to make the actual cross-connection in the street.

Ludgate Circus B.O.—The street tubes have been removed to a new position in this office, and a local tube, with power obtained from one of the street tubes, has been installed; the necessity for a hand pump has thereby been avoided.

Staff Notes.—It was very pleasant to observe the almost affectionate farewell which was accorded, by the telegraphists of the News Division, to Mr. R. M. Spratley on his retirement. Mr. Spratley was a mechanic who, for a generation at least, had charge of the T.S. pneumatic perforators, and faithfully fulfilled his duty.

The promotion of Foremen Mechanics Liston and Dykes, of the Central Telegraph Office Workshops, to the rank of Inspector, is worthy of note as indicating the trend of modern telegraphy in the direction of automatic machinery.

Typewriting telegraphy bids fair to bring about the supersession of skilled telegraphists by skilled mechanics.

ROLL OF HONOUR.

THE Board of Editors sincerely regrets to announce the deaths on active service of the under-mentioned members of the Engineering Department.

ROLL OF HONOUR.

ROLL OF HONOUR

Fourth List. (A) Army. (N) Navy. (R.N.D.) Royal Naval Division. (R.N.V.R.) Royal Naval Volunteer Reserve.

Name.	Rank.	District.
W. M. Adams (A) . . .	Labourer	N.
E. Aitchison (A) . . .	Unest. Skilled Workman	S. Lancs.
F. Ansell (A) . . .	Labourer	S. Mid.
S. Ashmore (A) . . .	"	N. Mid.
F. J. J. Barclay (A) . . .	"	London
J. A. Bickerton (A) . . .	Unest. Skilled Workman	N.E.
R. Binks (A) . . .	Labourer	N.
R. Bloomfield (A) . . .	Unest. Skilled Workman	Ireland
C. Brand (A).	"	N. Wa.
T. Burke (A)	"	S. Lancs.
D. D. Carruthers (A) . . .	Youth	Scot. W.
C. S. Carter (R.N.D.) . . .	Clerical Assistant	S.E.
E. H. Clarke (A)	Skilled Workman, Cl. II.	London
F. Couch (A)	Labourer	S.W.
O. F. G. Creber (A) . . .	Unest. Skilled Workman	London
H. J. de Bell (N)	Labourer	London
G. Dowler (A)	"	S. Mid.
J. Evans (R.N.D.)	"	London
W. Fellowes (A)	"	N. Mid.
W. Harmer (A)	"	London
A. Herrity (A)	Skilled Workman, Cl. II	N.E.
A. F. Hobbs (A)	Labourer	S. Mid.
J. W. Hunter (A)	Unest. Skilled Workman	S. Lancs.
P. L. Jackman (A)	Clerical Assistant	N. Mid.
W. Jennings (A)	Labourer	N.E.
T. Joiner (A)	"	London
C. Kane (N)	"	N. Wa.
D. Kennedy (A)	"	S. Lancs.
D. Laker (A)	"	S. Mid.
E. G. Layton (A)	Boy	London
J. A. Lee (A)	Unest. Skilled Workman	S. Lancs.
F. D. MacLanen (A)	"	N.E.
G. G. Meiklejohn (A) . . .	Youth	Scot. W.
J. Miller (A)	Labourer	E.
F. Minshell (A)	Youth	S. Lancs.
G. Morris (A)	Labourer	N. Mid.
W. Muir (A)	"	Scot. E.
J. Ormsby (A)	"	N.E.
W. F. Pearson (A).	Clerical Assistant	N.
A. S. Perriman (A)	Labourer	S.W.
C. H. Read (A)	Youth	S. Mid.
A. E. Sayers (A)	Unest. Skilled Workman	S. Mid.

HONOURS**MENTIONED IN DESPATCHES.**

Name.	Rank.	District.
P. F. Scull (A) . . .	Assistant Clerk	. London
G. H. B. Shoddick (A) .	Labourer	. N.
J. Shelvey (A) . . .	"	. Scot. E.
J. Sherwin (A) . . .	Unest. Skilled Workman	. N. Wa.
C. H. Spurway (A) . .	Labourer	. London
C. C. F. Staden (A) . .	Unest. Skilled Workman	. Eastern
F. Stapleford (A) . . .	Labourer	. N.
E. Weston (A) . . .	"	. S. Mid.
F. Wilson (A) . . .	Unest. Skilled Workman	. N. Mid.
G. F. York (R.N.V.R.) .	"	. Scot. W.

MENTIONED IN DESPATCHES.

THE Board of Editors has great pleasure in publishing the names of the under-mentioned officers of the Engineering Department who have been honoured by mention in the Commander-in-Chief's despatches, or by other mark of distinction. It will be observed that this initial list includes the names of thirty-six members of the Post Office Engineering Service, and the list is of exceptional interest to the staff in view of the fact that the "K" Company, Royal Engineers, has been singled out for special recognition. Prior to the outbreak of the war the "K" Company was engaged on Post Office Engineering duties in Ireland.

Heartly congratulations are tendered to all on the very signal honours that have been bestowed.

" K " COMPANY, R.E.

Maj. E. V. Turner. Mentioned in despatches (three times) and promoted to Brevet-Col.

Capt. D. C. Jones. Mentioned in despatches, awarded the Legion of Honour (Croix de Chevalier), and promoted Major.

Capt. K. E. Edgeworth. Mentioned in despatches (twice) and awarded the Military Cross.

Capt. A. L. Owen. Mentioned in despatch:

Lieut. J. Watson. Mentioned in despatch, awarded the Military Cross, and promoted Captain.

2nd Cpl. R. Birch. Mentioned in despatch.

Sergt. T. J. Bridges. " "

Cpl. A. T. Brittan. Awarded the Distinguished Conduct Medal.

2nd Cpl. J. Brown. Mentioned in despatch.

Cpl. W. A. Bultitude. " "

Sap. S. M. Chapman. Awarded the Distinguished Conduct Medal.

2nd Cpl. G. A. Crane. Mentioned in despatch.

Sergt. F. C. A. Eynott.	Mentioned in despatch.
Lce.-Cpl. W. J. Hall.	„ „
Sergt. G. S. Harris.	„ „
Cpl. A. C. Hopkins.	„ „
Supt. Clerk C. H. Hutton.	Mentioned in despatch and awarded the Military Cross.
2nd Cpl. C. Membry.	Mentioned in despatch.
Sap. G. Reddaway.	„ „
Cpl. S. G. Rickard.	Awarded the Distinguished Conduct Medal.
2nd Cpl. L. T. Silvester.	Mentioned in despatch.
Sergt. J. Smeeth.	„ „
Sergt. E. Stooke.	„ „
Lce.-Cpl. H. W. Wright.	„ „

Temp. Capt. W. M. Batchelor, R.E., Signal Section (Assistant Superintending Engineer, Northern District). Mentioned in despatches.

Sap. C. Redley, R.E. (Unestablished Skilled Workman, South Eastern District). Mentioned in despatches.

Lce.-Cpl. E. Hopkins, R.E., Signal Section (Labourer, London District). Mentioned in despatches.

Sap. F. V. Jones, R.E., Signal Section (Skilled Workman, Class II, North Western District). Mentioned in despatches.

Pte. H. Radcliffe, Gordon Highlanders (Lineman-in-training, North Western District). Distinguished Conduct Medal.

Pte. R. Binks, King's Royal Rifles (Labourer, Northern District). Distinguished Conduct Medal.

Sergt. A. E. Faithfull, R.E., Signal Section (Skilled Workman, South Eastern District). Distinguished Conduct Medal.

Lce.-Cpl. F. J. Gatwood, 1st Cambridgeshire Regiment (Clerical Assistant, Eastern District). Mentioned in despatches.

Pte. J. T. Sproates, 2nd Durham Light Infantry (Labourer, Northern District). Mentioned in despatches.

Pte. W. McFarlane, 2nd Royal Scots (Labourer, Scotland East District). Distinguished Conduct Medal.

Cpl. G. Repton, R.E., Signal Section (Skilled Workman, Class II, North Eastern District). Distinguished Conduct Medal.

Sergt. W. H. Wicks, Leinster Regiment (Unestablished Skilled Workman, South Midland District). Distinguished Conduct Medal.

Corporal George Repton is the second member of the Lincoln Section staff to gain the Distinguished Conduct Medal. It was awarded in this instance for work done under fire during the landing of the forces at the Dardanelles. The only intimation received, in addition to the bald official announcement, is contained in a letter from Corporal Repton dated July 28th, in which he says :

"I am pleased to say our O.C. has recommended me for the D.C.M. (which I did not expect) for picking up wires and getting them through under shell-fire. It was duty, and that is what I came for."

True: that was his reason for going, and the reason is worthy to rank with the achievement.



CORPORAL REPTON.

Corporal Repton, who was lineman at Gainsborough before the war, is with the G.H.Q. Signal Co., Mediterranean Expeditionary Force, at Cape Helles.

F. M.

LIST OF OFFICERS IN THE ENGINEERING DEPARTMENT HOLDING COMMISSIONS IN THE ARMY OR NAVY (SECOND LIST).

Name.	District.	Military or Naval Rank.	Corps.
McGowan, C. R. .	E. in C.O.	2nd Lieut. .	Hon. Artillery Comp'y.
Johnson, J. A. .	"	"	Royal Field Artillery,

STAFF CHANGES.

STAFF

Name.	District.	Military or Naval Rank.	Corps.
Hudson, J. A.	Testing Branch	2nd Lieut.	Royal Engineers Sig. Sect.
Herbert, R. C.	Lond. Eng. Dist.	„	9th Battn. Royal West Surrey Regt. (The Queen's).
Matthews, F.	„	„	3/24th County of Lond. Regt.
Lamb, S. E.	„	„	174th Brigade Royal Field Artillery.
Tucker, G. H.	„	„	5th Battn. Royal Fus.
Sirett, A. W.	South Wales	Lieut.	Royal Engineers Sig. Sect.
Tissington, H. G.	„	2nd Lieut.	Do.
Whitchurch, G.	„	„	„
Norman, R. D. S.	Northern	„	Roy. Engineers, Special Reserve, Sig. Sect.
Barton, C. T.	North-Western	„	Royal Field Artillery.
Laidlaw, J. B.	Scotland West	Lieut.	Asst. Military Director, Post and Telegraphs, German Cameroons.
Smith, C. P.	South Western	2nd Lieut.	14th Notts and Derby Regt.

STAFF CHANGES.

POST OFFICE ENGINEERING DEPARTMENT.

PROMOTIONS.

Name.	From.	To.	Date.
Ramsay, M.	Asst. Staff Engr., E. in C.O.	Staff Engr., E. in C.O.	1 : 8 : 15
Allan, W.	Exec. Engr., Scot. W. Dist.	Asst. Suptg. Engr., N. Wa. Dist.	1 : 9 : 15
Scarr, W.	Asst. Engr., E. Dist.	Exec. Engr., Technical Section, E. Dist.	13 : 8 : 15
Waller, J.	Engr., 2nd Cl., E. in C.O.	Asst. Engr., Ireland	1 : 7 : 15
Stanton, J. D.	Engr., 2nd Cl., S.W. Dist.	Asst. Engr., E. in C.O.	4 : 7 : 15
Chambers, J. L.	Chief Insp., Scot. W. Dist.	Asst. Engr., Scot. W. Dist.	To be fixed later

STAFF

STAFF CHANGES.

TRANSFERS.

Name.	Rank.	Transferred from.	To.	Date.
Watts, A.	{ Staff Engr. Suptg. Engr. }	E. in C.O.	N. Mid. Dist.	1 : 8 : 15
France, W. M.	Staff Engr.	E. in C.O. (Equipment Section)	E. in C.O. (Local Lines Section)	1 : 8 : 15
Eldridge, E. J.	Supt. Engr.	N. Mid. Dist.	S.W. Dist.	1 : 8 : 15
Withers, C. A.	3rd Cl. Clerk	"	N. Wa. Dist.	11 : 7 : 15
Thorne, H. D.	"	Northern Dist.	S.E. Dist.	4 : 8 : 15
Smith, F. M.	Asst. Engr.	E. in C.O.	N. Mid. Dist.	1 : 9 : 15
Hanna, W.	"	"	N. Wa. Dist.	10 : 4 : 15
Morgan, J.	"	"	S.W. Dist.	1 : 6 : 15
Innes, J.	"	"	Scot. E. Dist.	6 : 6 : 15
Ellson, F. A.	"	"	S. Wa. Dist.	5 : 6 : 15
Hannaford, F. S.	"	London Dist.	N. Wa. Dist.	6 : 6 : 15

RETIREMENT.

Name.	Rank.	District.	Date.
Tremain, F.	Suptg. Engineer	S.W. District	Superannuated 1 : 8 : 15
Gleed, S. W.	Asst. Engineer	E. in C.O.	Resigned 22 : 6 : 15

BOARD OF EDITORS.

T. F. PURVES, M.I.E.E., Chairman. J. W. ATKINSON, A.M.I.E.E.
 A. W. MARTIN, A.M.I.E.E. A. O. GIBBON, A.M.I.E.E.
 Major A. C. BOOTH, R.E. W. T. HARRIS.
 W. CRUICKSHANK, A.M.I.E.E., Managing Editor.

COMMUNICATIONS.

All Remittances and Communications should be addressed to the **MANAGING EDITOR**, P.O.E.E. JOURNAL, Engineer-in-Chief's Office, G.P.O. West, London, E.C.

A few copies of Part 1, Vol. 1, and Part 1, vol. 7, of the JOURNAL are required by the Board. Full price will be paid for copies in good condition, or another part can be sent in exchange. The JOURNALS may be sent to the Managing Editor direct, or through the local agents.

Binding covers and copies of the Contents Index for Vol. 7 are now available, and may be obtained from the local agents for 1s. and 2d. respectively. Subscribers can have their copies bound, with index included, at a cost of 1s. 9d., by sending the JOURNALS to the local agents. Orders should indicate whether the original binding covers, or the later pattern, are required.

A supply of the first instalment of the Station List of Engineering Officers eligible for membership of the Institution, issued with the April, 1914, number of the JOURNAL, and including all officers down to Assistant Engineers, is in stock, and copies can be obtained on demand, price 3d. each.



TRUNK AND JUNCTION CIRCUIT DEVELOPMENT.

By I. H. JENKINS, A.M.I.E.E., and H. W. WHITE,
Engineer-in-Chief's Office.

THE transfer of the ex. National Telephone Company's undertaking to the Department has created many problems, not the least of which is perhaps that of the rearrangement of trunk and junction lines to meet the new conditions. Much uncertainty possibly exists as to the standard circuit arrangements for the new conditions, and it is thought that a *résumé* of the phases through which the problem has passed to its present development will be of some general utility.

In order to properly appreciate the question, it is well to remind ourselves of the conditions which existed before the transfer, when the country was divided into separate trunk areas. Intercommunication between the exchanges within each area was effected over "junction" lines, which were considered as part of the local system, whilst communication between exchanges in different areas was made over "trunk" lines. The trunk lines terminating on special trunk exchanges in each trunk area formed the trunk system, owned and operated by the Post Office. Connection between the trunk system and the local exchanges was in all cases made over trunk junctions radiating from the trunk exchange in its respective area. After the transfer had been effected, there thus existed in a great many towns separate trunk and local exchanges entirely unwarranted from an operating point of view, as trunk calls could quite properly be handled, generally with an appreciable saving in operating costs, on

the local exchange. There were also, of course, many anomalies, such as local exchanges comparatively near each other, but with no direct junction connection because a boundary between two areas happened to intervene.

On the amalgamation of the trunk and local systems, a policy of closing the unnecessary trunk exchanges and connecting the trunks direct to the local exchanges was followed. From an engineering point of view, therefore, the old trunk areas no longer exist; in fact they are only retained for accounting purposes. Of the original 287 trunk exchanges existing at the time of the transfer, some 217 have already been closed, and it is intended ultimately to have only about 12 separate trunk exchanges throughout the kingdom.

The Department's standard trunk exchange circuits on a magneto call and loop current clear basis are well known; the principle of the cord circuit is illustrated in 14. When used for trunk-to-trunk connections the transmission losses are not excessive, and no earth connection exists to unbalance the line and cause inductive disturbance. When, however, connection is required between a trunk and the junction to the local exchange automatic signalling is necessary on the trunk junction, and is effected by means of coils with a centre point to earth connected across the line. The impedance and balance of these coils is sufficiently good to guard against creating inductive disturbance, and in the case of a junction to a C.B. exchange a repeating coil is inserted, which effectively prevents the local subscriber's circuit, with its battery-feeding coils, from degrading the trunk line.

C.B. local exchange cord circuits had hitherto been provided with low impedance or indefinitely balanced battery feeding coils, designed for working subscribers' lines and the comparatively short junction between exchanges within the trunk areas. It soon became evident that these cord circuits were unsuitable for direct connection to the longer lines it was desired to bring over from the trunk exchanges, as considerable inductive disturbance was liable to be created.

For traffic reasons it was desired to operate the shorter trunks on a "junction" basis—that is, with circuits so arranged that the control of the connection is in the hands of the "A" operator, whose (in the case of a C.B. or C.B.S. exchange) answering and calling supervisory signals are controlled respectively by the calling and called subscriber's switch-hooks. It has been settled that the limit for such lines shall be sixty route miles—a reasonable limit from an engineering and traffic point of view.

The problem, therefore, was to devise suitable circuits for use on local exchanges for the accommodation of:

(a) Trunk lines (*i. e.*, lines worked on a magneto call and loop current clear basis) of over sixty route miles in length, the cord circuit

for which should be suitable for trunk-to-trunk, trunk-to-junction, or trunk-to-subscriber connection.

(b) Junction lines (*i. e.*, lines affording automatic through supervisory control) up to sixty miles in length, the cord circuit for which should be suitable for junction-to-junction, or junction-to-subscriber connection.

The principle adopted has been to regard the C.B. manual exchange as standard, at which shall be fitted circuits for trunks and junctions based on the assumption that the distant exchanges are standard trunk or C.B. respectively. In the case of non-C.B. exchanges working to C.B. exchanges, apparatus shall be associated with the line at the non-C.B. end to produce C.B. signalling conditions, and so link up the two systems. This principle admits of "clean" circuits, with a minimum of transmission loss and a maximum of flexibility, being used at the C.B. (usually the main) exchange. The unavoidable transmission loss represented by the "link" at the distant end automatically disappears as soon as that exchange is converted to C.B.; further, no alterations are required at the C.B. exchange when a distant exchange is converted to another system. The principle of inserting a repeater between the trunk line and a subscriber's or a junction line has been followed in order to insure against the risk of the trunk line being degraded by direct connection to a faulty or unbalanced line. Other features of the design of the circuits are dealt with in the description which follows. Much investigation in connection with the balancing of the battery feeding and signalling coils has been undertaken, which might well form the subject of a separate and subsequent article.

DETAILS OF THE CIRCUITS.

1 shows in diagrammatic form the principles of standard magneto, C.B.S., and C.B. subscribers' line and instrument circuits. It is thought that these figures may be of use for reference in connection with the circuits which follow.

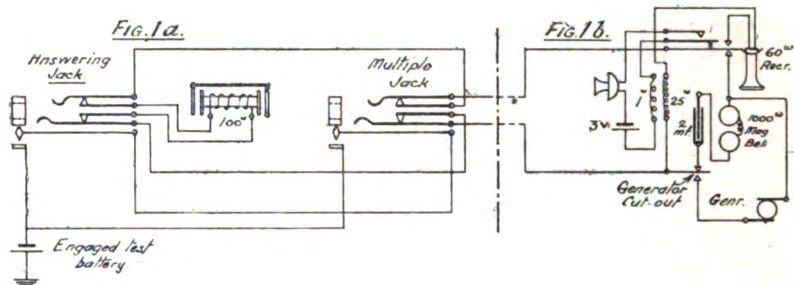
Junction circuits are of two distinct types, *viz.*, jack-ended and plug-ended. All ringing junctions, except in exceptional cases and at some large exchanges, are intended in future to be worked jack-ended, whilst all order wire junctions must, in the nature of things, continue to be worked as plug-ended. The advantages of jack-ended working for ringing junctions are that team work between "B" operators and between "B" and adjacent "A" operators is more effective, and loads for the "B" operator can be readily made up when junctions are worked both ways.

JUNCTION LINE CIRCUITS.—**2** shows the line circuits for out-

TELEPHONES TRUNK AND JUNCTION CIRCUIT.

going and jack-ended incoming junctions at C.B. exchanges, whilst 3 shows typical incoming plug-ended equipment at C.B. exchanges.

SUBSCRIBERS' CIRCUITS. Magneto Exchanges.



Non Multiple Exchanges.

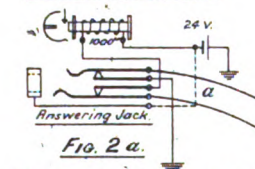


FIG. 2 a.

Multiple Exchanges.

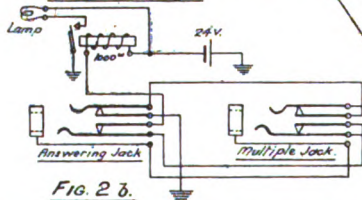
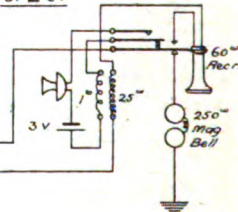


FIG. 2 b.

C.B.S. EXCHANGES.

(a) This connection is only necessary when the switchboard is equipped with cord circuits as shown in 9 Fig. 2.

FIG. 2 c.



C. B. EXCHANGES.

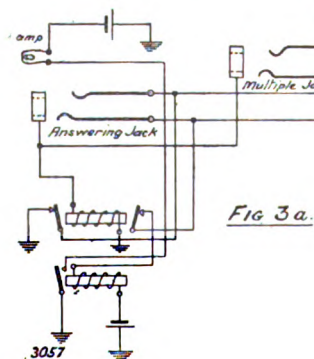


FIG. 3 a.

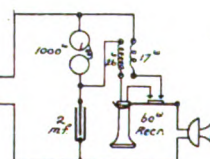


FIG. 3 b.

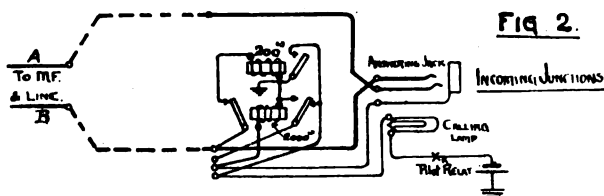
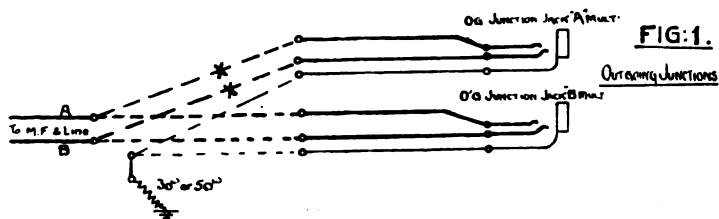
I.—SUBSCRIBERS' CIRCUITS.

4 and 5 show the jack-ended line circuits at magneto and C.B.S. exchanges, whilst plug-ended circuits for magneto exchanges are

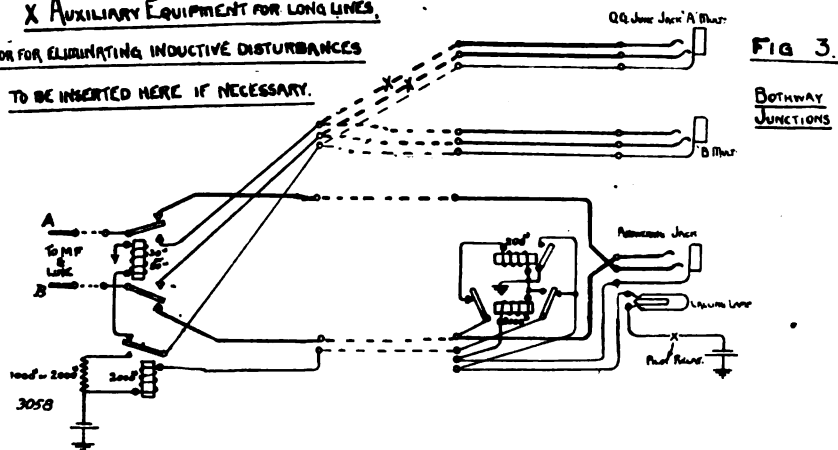
shown in 6. 7 and 8 show circuits for use at trunk exchanges when it is required to work lines therefrom to local exchanges on a junction signalling basis.

C.B. EXCHANGES

JACK ENDED JUNCTIONS



X AUXILIARY EQUIPMENT FOR LONG LINES.
OR FOR ELIMINATING INDUCTIVE DISTURBANCES
TO BE INSERTED HERE IF NECESSARY.



2.—JACK-ENDED JUNCTIONS. C.B. EXCHANGES.

JUNCTION CORD CIRCUITS.—Typical cord circuits for use in connection with these junctions are shown in 10 for C.B. exchanges, and in 9 for magneto and C.B.S. exchanges.

Fig. 1, 9, is an ordinary magneto cord circuit modified for jack-ended junction working. The condenser in series with the ring-off

JUNCTION CIRCUITS.

C.B. No's 1, 10 & 12 EXCHANGES.
O. W. KEYLESS JUNCTIONS - 22 VOLT SYSTEMS.
INCOMING.

FIG 1. WITHOUT LOCAL SUPERVISORY SIGNAL. FOR LINES
INCOMING FROM C.B. C.B.S & TRUNK EXCHANGES. to go
to go

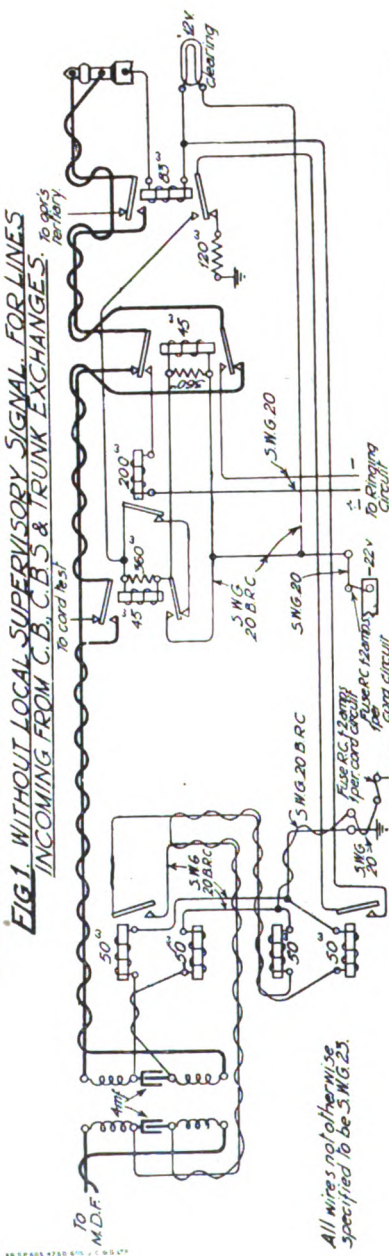
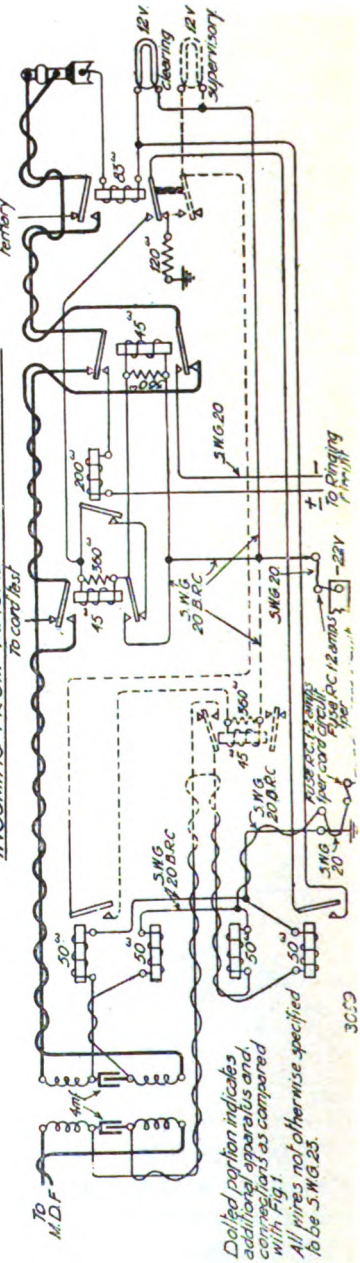


**FIG. 2. WITH LOCAL SUPERVISORY SIGNAL FOR LINES
INCOMING FROM MAGNETO EXCHANGES.**



3.—PLUG-ENDED JUNCTIONS. C.B. EXCHANGES.

JUNCTION CIRCUITS.

MAGNETO EXCHANGES.

FIG. 1. OUTGOING JUNCTION.

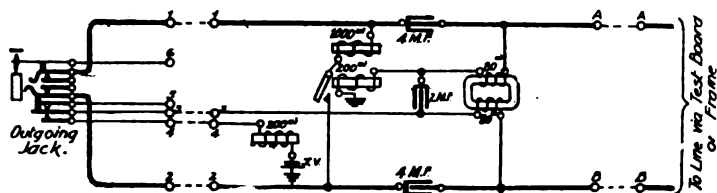


FIG. 2. INCOMING JUNCTION.

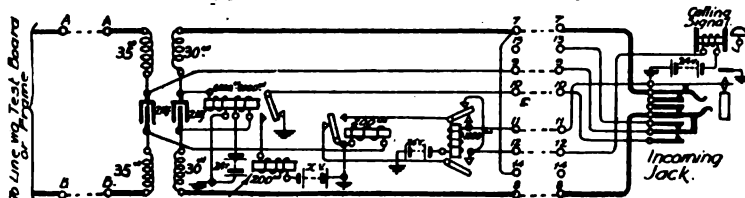
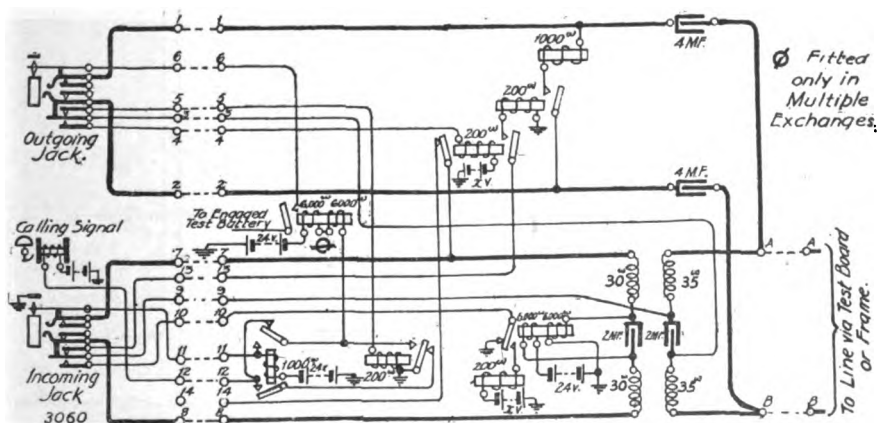


FIG. 3. BOTHWAY JUNCTION



4.—JACK-ENDED JUNCTIONS. MAGNETO EXCHANGES.

JUNCTION CIRCUITS.

C.B.S. EXCHANGES

FIG. 1. OUTGOING JUNCTION

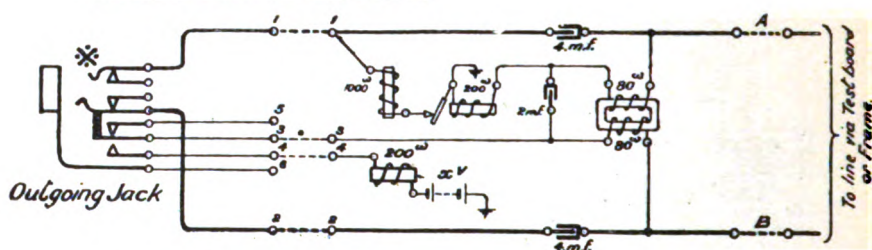


FIG. 2. INCOMING JUNCTION

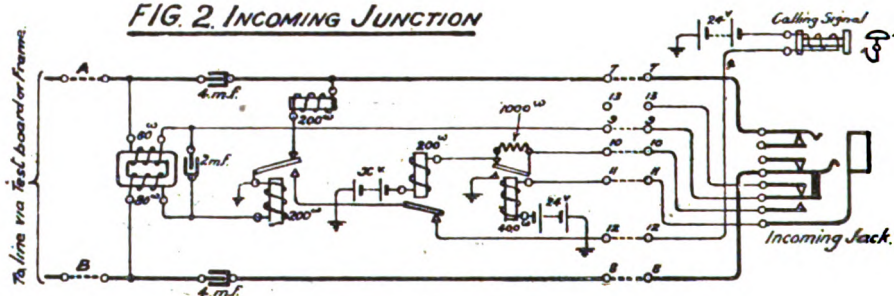
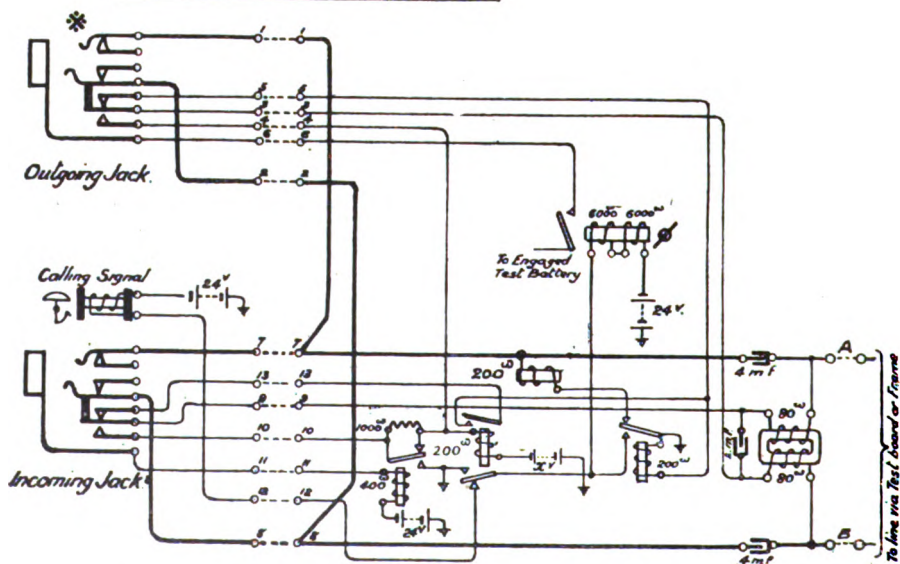


FIG. 3. BOTHWAY JUNCTION



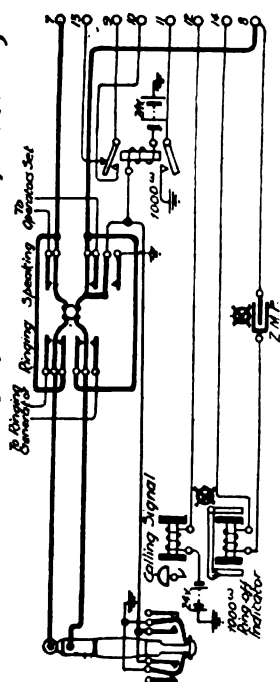
Ø Fitted only in multiple exchanges

306. In some non-multiple Exchanges battery is connected to the bush of the Jack.

5.—JACK-ENDED JUNCTIONS. C.B.S. EXCHANGES,

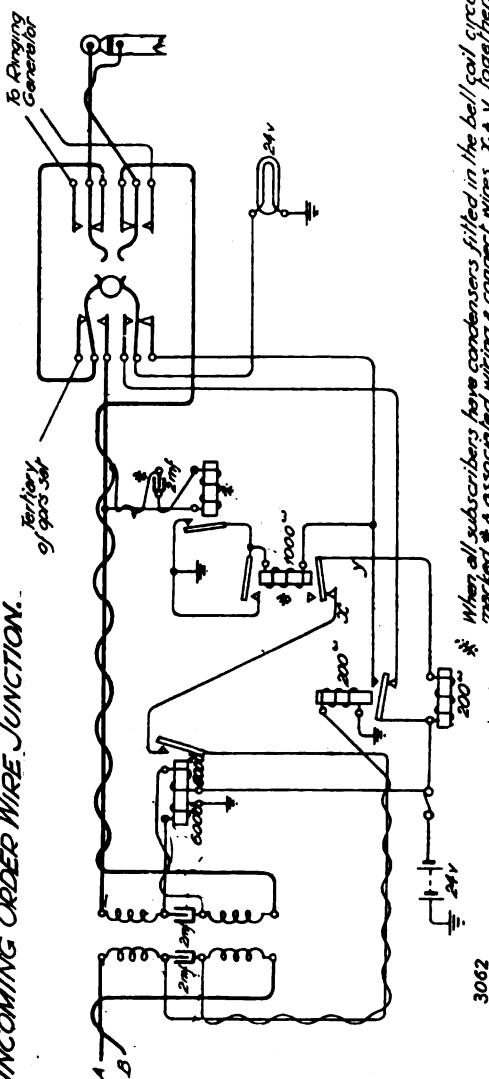
JUNCTION CIRCUITS.

FIG. 4 PLUGGED INCOMING OR BOTHWAY JUNCTION:
When Junctions are Plugged this Figure takes the place of the Incoming Jack and calling signal shown in Fig. 2 & 3. Diagrams 5



~~Do not~~ Omit when all subscribers have condensers fitted in the Bell Coil Circuits

FIG. 5. INCOMING ORDER WIRE JUNCTION.



When all subscribers have condensers fitted in the bell coil circuits omit apparatus marked # & associated wiring & connect wires X & Y together.

6.—PLUG-ENDED JUNCTIONS. MAGNETO EXCHANGES.

JUNCTION CIRCUITS.

**TRUNK EXCHANGES
D / TYPE OF SECTIONS**

FIG 1 OUTGOING JUNCTION

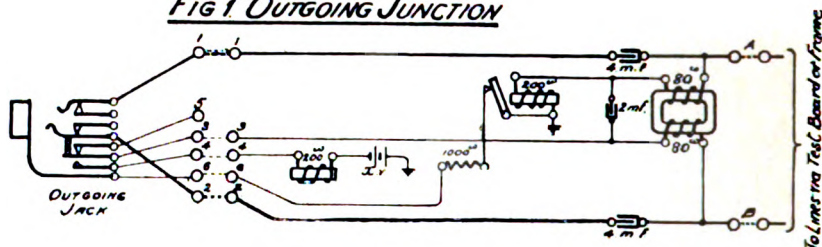


FIG 2 INCOMING JUNCTION

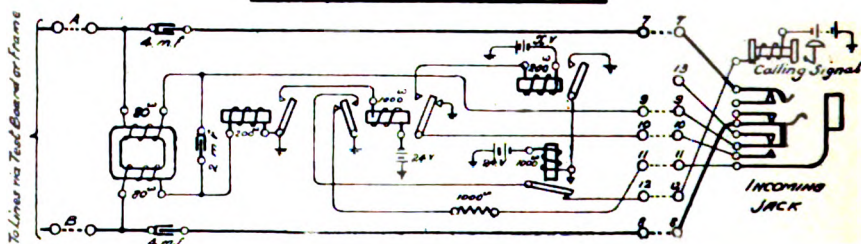
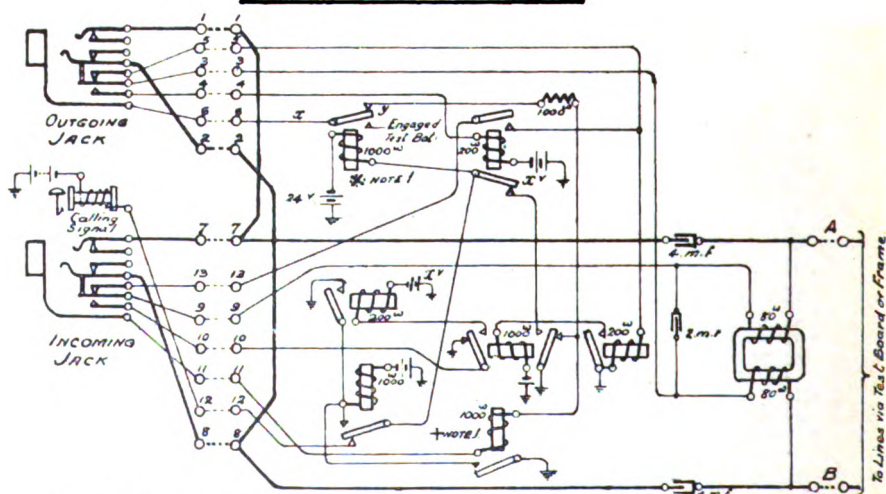


FIG 3 BOTHWAY JUNCTION



NOTE 1. In non-multiple Exchanges omit Relay $\times$, connect $\times$ & y together, replace Relay $+$ by a Res: 1000.

JUNCTION CIRCUITS.

LAMP SIGNALLING TRUNK EXCHANGES

FIG 1 OUTGOING JUNCTION

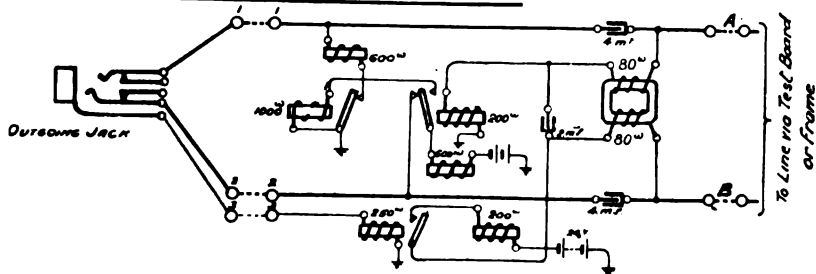


FIG 2 INCOMING JUNCTION

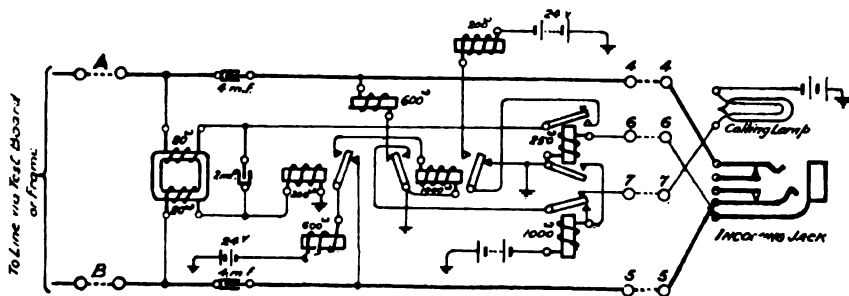
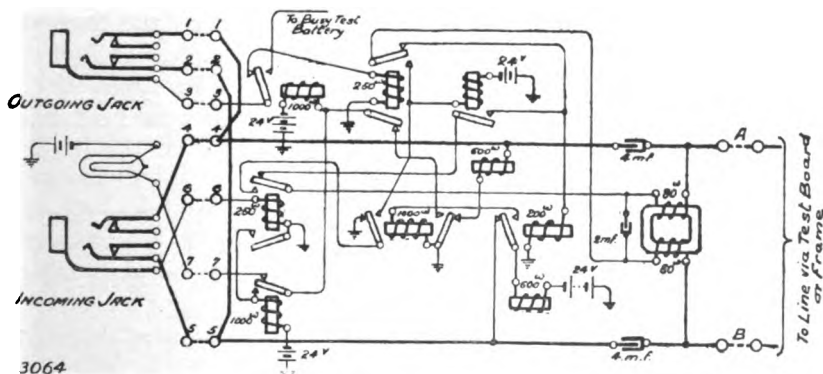


FIG 3 BOTHWAY JUNCTION



8.—JUNCTIONS. TRUNK EXCHANGES, LAMP SIGNALLING.

indicator is necessary for through signalling, either when an incoming junction is extended to an outgoing junction (Figs. 1 and 2 of 4), or when an incoming junction is extended to a "condensed" magneto subscriber's circuit (Fig. 2 of 4 and Figs. 1a and 1b of 1).

Figs. 2 and 3, 9, show the type of cord circuits fitted on C.B.S. switch-boards.

The cord circuits shown in Figs. 1, 2 and 3, 9, are suitable for establishing the following connections :

Answering plug.				Calling plug.			
(a)	Subscriber	.	.	.	.	to	Subscriber.
(b)	"	.	.	.	.	to	Outgoing junction.
(c)	"	.	.	.	.	to	Trunk.
(d)	Incoming junction	.	.	.	.	to	Subscriber.
(e)	"	"	.	.	.	to	Outgoing junction.
(f)	"	"	.	.	.	to	Trunk.
(g)	Trunk	.	.	.	.	to	Subscriber.
(h)	"	.	.	.	.	to	Outgoing junction.
(i)	"	.	.	.	.	to	Trunk.
(j)	Outgoing junction	.	.	.	.	to	Subscriber.
(k)	"	"	.	.	.	to	Outgoing junction.
(l)	"	"	.	.	.	to	Trunk.

The conditions in (e) and (f) arise when a call is received and the trunk is available for immediate use.

The conditions in (j), (k), and (l) occur at periods when the junctions are not giving a "no delay" service, and it is necessary to ticket the calls.

10 shows the new cord circuits for jack-ended junction positions at C.B. exchanges. Fig. 1 relates to 22-volt systems, and Fig. 2 to 40-volt systems. Battery and earth are applied to the cords *via* impedances consisting of retardation coils and relays, and through a repeater. This device overcomes the difficulties due to inductive disturbances that were experienced with the older types of C.B. double-ended cords (see further remarks under "General Features"), and incidentally makes it necessary to use 30 volts on the lines for speaking in the case of the 22-volt system. These cord circuits are suitable for establishing the same connections as the magneto and C.B.S. cords just described, except where a trunk is concerned.

14 shows the cord circuits at existing trunk exchanges, modified for working trunk lines by junction signalling methods.

The cord circuit in Fig. 1 is suitable for making the following connections :

Answering plug.				Calling plug.			
(a)	Trunk	.	.	.	.	to	Trunk.
(b)	„	.	.	.	.	to	Outgoing junction (old or new form).
(c)	„	.	.	.	.	to	Transfer circuit or <i>vice versa</i> .
(d)	Incoming junction	.	.	.	.	to	Trunk.
(e)	„	„	.	.	.	to	Outgoing junction (old or new form).
(f)	„	„	.	.	.	to	Transfer circuit.
(g)	Outgoing junction	(new form)	.	.	.	to	Outgoing junction (new or old form).
(h)	„	„	ditto	.	.	to	Trunk.
(i)	„	„	„	.	.	to	Transfer circuit or <i>vice versa</i> .

The cord circuit shown in Fig. 2 can also be used to set up the same connections, but in this case the “answering plug” may be used in the jacks of junctions of the old form. This additional facility is, however, not one that carries with it any benefit in practice.

The conditions in (d) arise when the trunk is available for immediate use, and those in (g), and (h) at times when the calls, having been ticketed, are being set up in their correct turn.

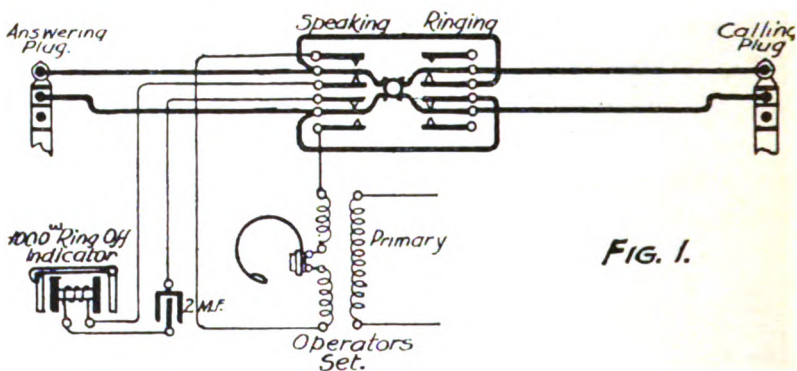
GENERAL FEATURES OF JUNCTION CIRCUITS.—The arrangements, as far as each individual exchange is concerned, are universal in their application. The circuits shown in 5 for a C.B.S. Exchange will, for example, work to the corresponding circuits shown in the remaining diagrams for other types of exchanges. The circuits, therefore, though primarily designed for association with C.B. exchanges, can, if justified by traffic signalling requirements, the prospect of early conversion to C.B., or for other reasons, be used between any two types of exchanges, neither of which need be C.B.

The circuits will show on investigation that in each case the “calling” and “clearing” signals are effected automatically over the “B” line, while the supervisory signals are transmitted automatically over the “A” line.

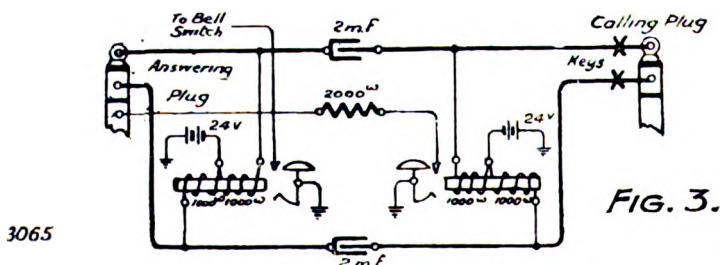
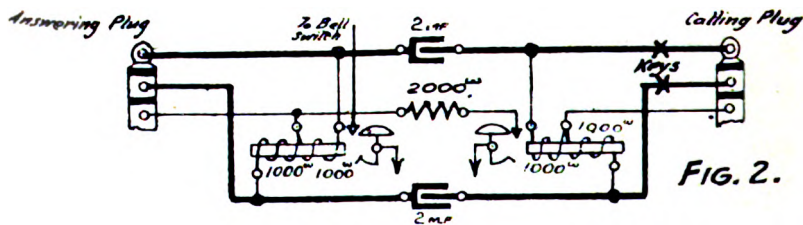
In devising these circuits special attention had to be directed to overcoming the effects of insulation loss and voltage variations on the operation of the relays, to obtaining the signals with the minimum consumption of primary battery materials, to the maintenance of balanced electrical conditions in the apparatus under both talking and signalling conditions, so that any noise on the lines might not be augmented, and to the retention of the highest possible speaking efficiency, having due regard to all other facilities. The

CORD CIRCUITS.

MAGNETO EXCHANGES.



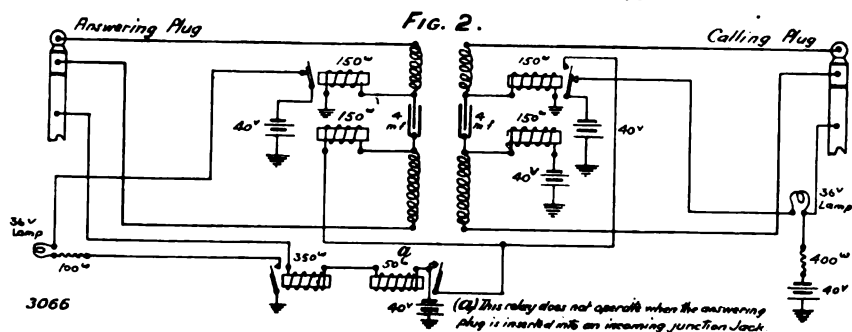
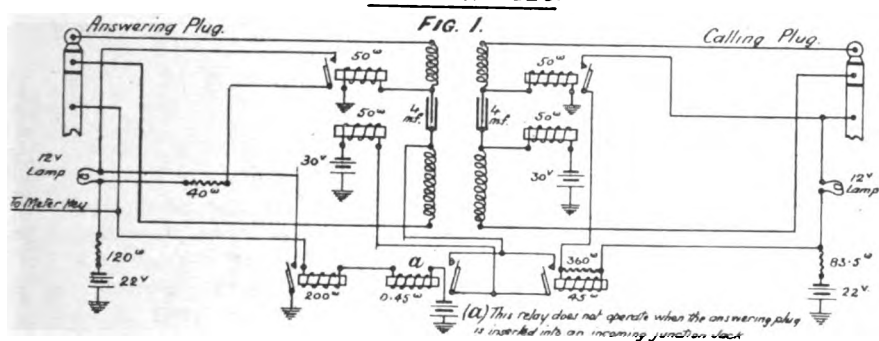
C.B.S. EXCHANGES



9.—CORD CIRCUITS. MAGNETO AND C.B.S. EXCHANGES.

circuits are designed with sufficient margin to work satisfactorily under wet weather conditions in the British Isles; that is to say, they should work without any relay readjustments on a line sixty miles in length, having an insulation resistance of 100,000^Ω per mile of single line one day and infinity the next, whether the voltage of the signalling battery be at its maximum of 28 volts or its minimum of 20 volts. With this object in view, the relay is in all cases placed at the end of the line distant from the source of power operating .

CORD CIRCUITS. **C.B. EXCHANGES.**



10.—CORD CIRCUITS FOR OPERATING JACK-ENDED JUNCTIONS. C.B. EXCHANGES.

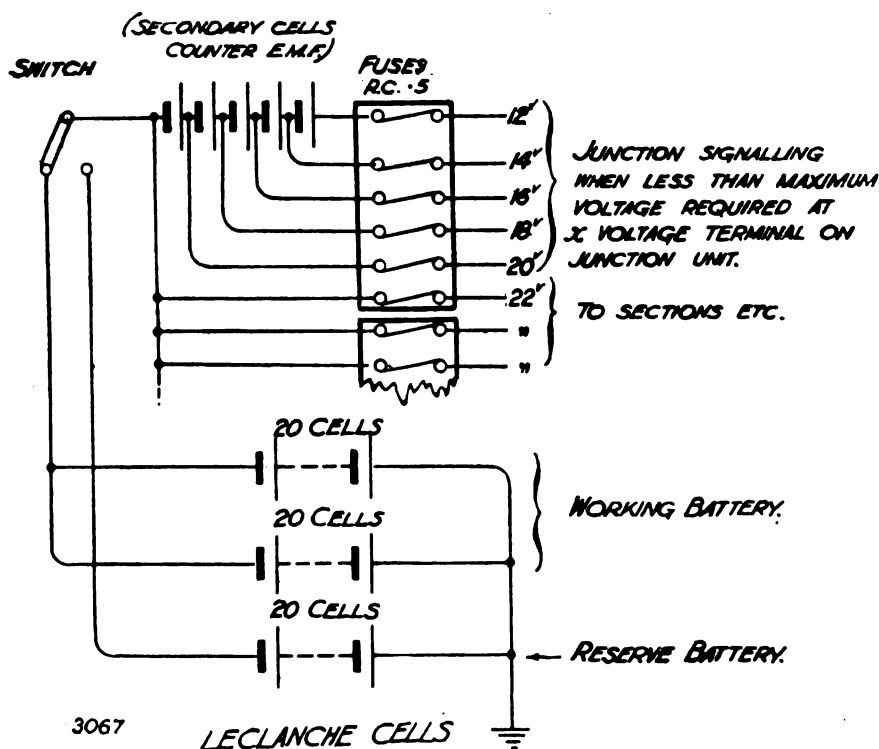
The method of connecting primary cells to the "X voltage" points in the diagrams, so as to obtain the minimum voltage that is necessary for satisfactory working, is shown in **11**. Where secondary cells are available and the cost of current for charging them is small enough to justify it, the full voltage of the cells, providing it does not exceed 40 volts, would be connected to the "X voltage" points.

The electrical balance of the lines is maintained by the device of bridging the line with a high 80^Ω + 80^Ω impedance coil, or by using a very efficient repeater, battery and earth being connected in either

case to the centre points of these through impedances in the form of relays and retardation coils.

It will be observed that the two impedances are connected together at the centre point of the bridging coil or repeater by means of a condenser. The relay and retardation coils are thus in a

PRIMARY BATTERY DISTRIBUTION



II.—METHOD OF DISTRIBUTING VOLTAGES TO OPERATE JUNCTION APPARATUS.

measure in parallel, and any difference in effective impedance between the two coils due to the current flowing, or difference in construction, does not appreciably affect the balance of earth connection to the lines.

Examples of these arrangements may be seen in 4, 5, and 10.

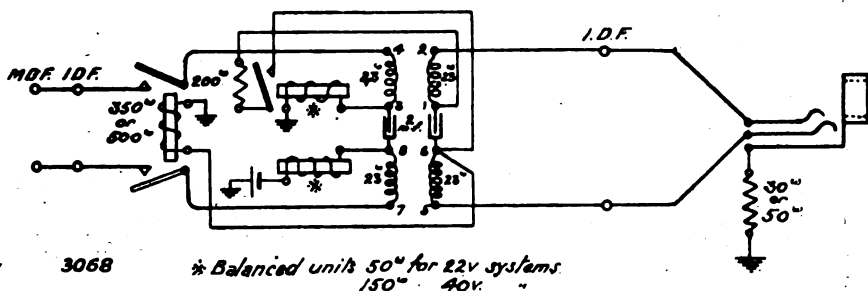
In 4, 5, 7, and 8 the lines are further safeguarded against noise

by the avoidance of relay contacts in the speaking circuit. The multiple wiring is of the branching type for the same purpose. The multiple is not shown in the diagrams.

The 1000^m bridging coil shown in Fig. 1 of 4 is required for through signalling when one automatic signalling exchange is extended to another at a magneto exchange; that is, when Fig. 2, 4, is extended by the cord circuit shown in Fig. 1, 9, to Fig. 1 of 4.

The arrangements of Figs. 2 and 3 of 4, 7, and 8 permit the operator to disconnect in advance of the receipt of a junction clear. In doing so, the calling signal is locked out until the relay which

C.B. Nos 1, 10 & 12 EXCHANGES.
OUTGOING JUNCTION AUXILIARY
EQUIPMENT FOR ELIMINATING
INDUCTIVE DISTURBANCES ON
JUNCTIONS DUE TO UNBALANCED
EXCHANGE APPARATUS.



12.—NOISE-ELIMINATING EQUIPMENT.

controls it is released by the operator disconnecting at the distant exchange. The normal operating arrangements at magneto and trunk exchanges are thus preserved.

The calling signal in Figs. 2 and 3 of 4 acts as a clearing signal when the junction is cleared at the outgoing end, if the connection has not already been taken down at the incoming end.

In 2, two multiples are shown on the outgoing sides of the junctions. The "A Multiple" is for use with the ordinary cord circuits with which the older types of C.B. exchanges are equipped. These cords will not be used for long distance calls; consequently, if the conditions are found to be noisy there is no serious transmission objection to the permanent insertion in the offending line of "noise eliminating equipment," as shown in 12 at the points marked X X in the respective figures of 2.

The "B Multiple" is used for long distance connections in conjunction with the high grade cord circuits shown in **10**.

METHOD OF MOUNTING APPARATUS AT SMALL EXCHANGES.—The junction equipments shown in **4**, **5**, **7**, and **8** are supplied mounted and wired ready for use. The relays, coils, condensers, etc., are compactly made up into small units with terminals which are numbered to correspond with those given in the explanatory figures. To bring a unit into use it is only necessary to run cross connections to the answering and calling jack equipment, as shown by the dotted lines in the diagrams.

The following are the sizes of the base boards of the units for the equipments shown in **5**, and are typical of the others :

Outgoing unit	.	.	.	.	10 in. × 5 in.
Incoming unit	.	.	.	.	10 in. × 7 in.
Bothway unit	.	.	.	.	10 in. × 12 in.

The last-named unit occupies the same space as the two together that precede it. This facilitates future rearrangements when a change from bothway working to divided working becomes necessary on account of development. The wiring from the switchboard to the unit junction rack, or its equivalent, is so arranged that this can be done without necessitating the running of additional cables.

The junction units can either be mounted on a wall or fitted on a rack. In either case a unit that is faulty can be replaced in emergency readily by a workman who is not skilled technically, thus reducing the period of interruption.

TRUNK CIRCUITS.—**13** shows diagrammatically the termination of trunks in various type exchanges in accordance with the following schedule, which also indicates the type of cord circuit used with the respective equipments.

Fig. **1** used at Trunk Exchanges Cord Circuit **14** Figs. **1** or **2**.

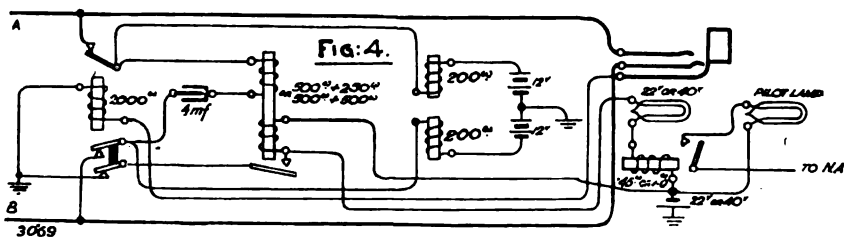
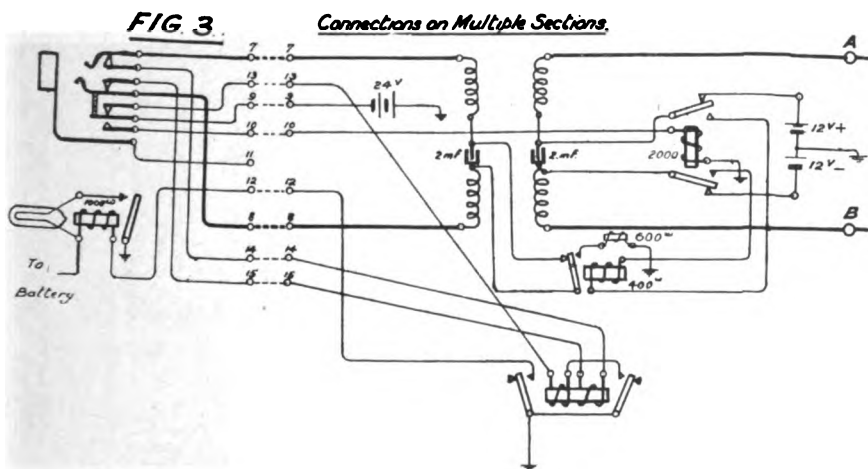
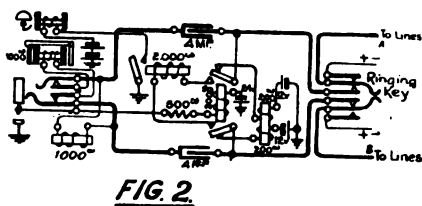
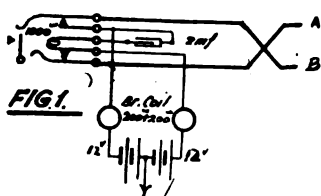
"	1	"	C.B.S.	"	"	"	9	"	2 .
"	3	"	C.B.S.	"	"	"	9	"	3 .
"	2	"	Magneto	"	"	"	9	"	1 .
"	4	"	C.B.	"	"	"	15	"	1 and 2 .

All these line circuits are on the well-known principle of magneto call and loop current clearing. **14** shows the trunk exchange cord circuit; Fig. **1** is the standard lamp signalling exchange cord modified by the addition of battery connection to the sleeve of the answering plug, and is suitable for working ordinary trunks (**13**, Fig. **1**), as well as junctions to **8**. (See also remarks under "Junction Cord Circuits.")

15 shows the trunk cord circuits for C.B. exchanges, Fig. **1** for 22-volt exchanges and Fig. **2** for 40-volt exchanges. These are designed solely for handling trunk calls, and embody, when used for trunk-to-trunk connections, similar features to the standard trunk

exchange cord (14, Fig. 1). When used for trunk to junction or subscriber connections they embody the features formerly obtaining when a trunk was connected over a junction outgoing from the trunk

TRUNK CIRCUITS



13.—TRUNK CIRCUITS.

exchange to a line on the C.B. exchange; that is, the insertion of a repeater between the trunk and the local line. There is, however, the added advantage of there being no connection to earth on the trunk side of the repeater. The battery is fed to the subscriber's

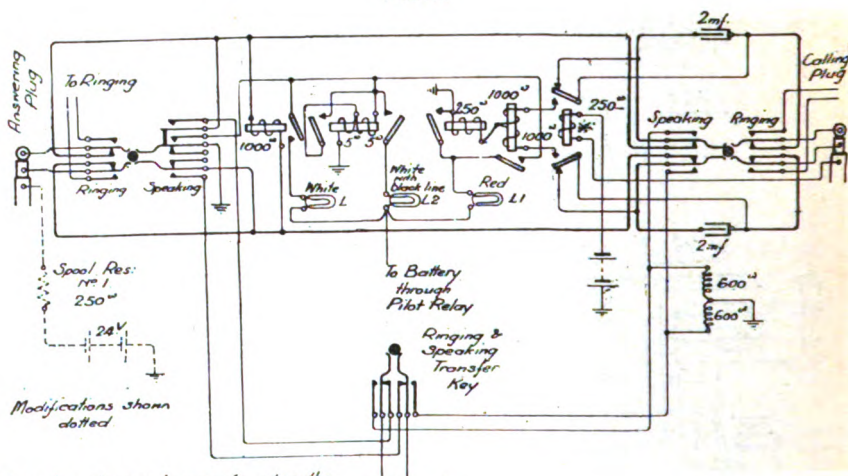
TELEPHONES TRUNK AND JUNCTION CIRCUIT.

line in a similar manner to the junction cord circuit, shown in 10, to avoid inductive disturbances.

CORD CIRCUITS.

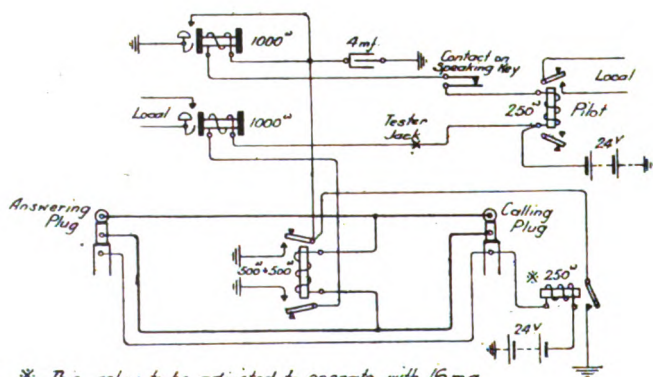
TRUNK EXCHANGES

FIG. 1.



*This relay does not operate when the calling plug is inserted in a Trunk or Trunk transfer circuit jack.

FIG. 2

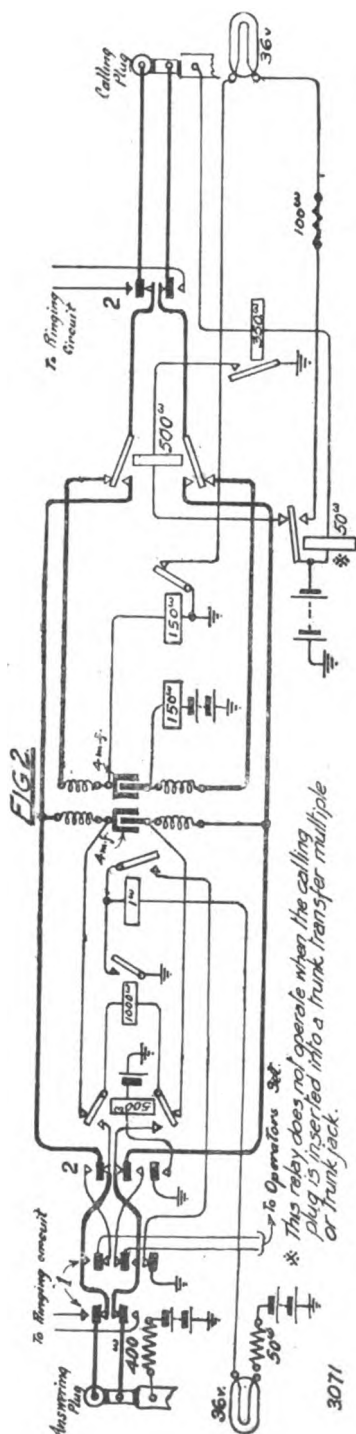
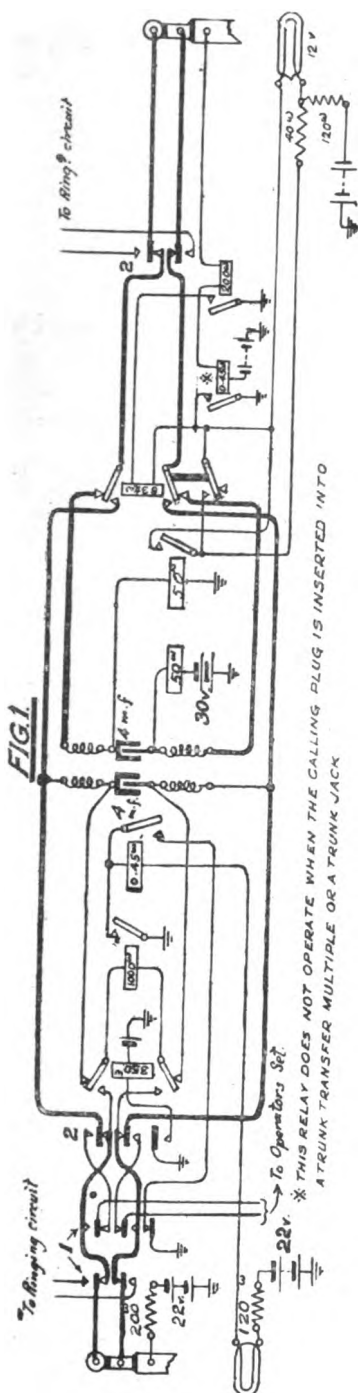


* This relay to be adjusted to operate with 16 m.a. and to release when current reduced to 6 m.a.
3070

14.—CORD CIRCUITS. TRUNK EXCHANGES. FIG. 1.—LAMP SIGNALLING.
FIG. 2.—NON-LAMP SIGNALLING.

They afford all the facilities usually associated with trunk cord circuits. For convenience, the speaking side of the key associated with the "calling plug" is shown on the "answering" side of the

JACK-ENDED TRUNKS. SORD CIRCUITS.

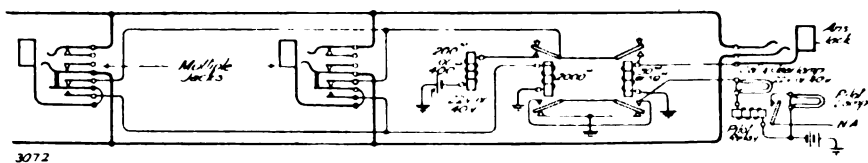


15.—CORD CIRCUITS FOR OPERATING TRUNK CIRCUITS.

cords. As compared with the usual trunk cord circuit arrangements shown in 14, Fig. 1, the manipulation is somewhat simpler. Disconnection facilities are obtained without the aid of a "speaking transfer" key, and the operator is enabled to test a circuit for "engaged" without first throwing a key to disconnect the trunk.

Trunks are never multiplied, on account of operating considerations, when working on a delay basis; when, therefore, sufficient trunk positions exist it is necessary to fit transfer circuits; 16 shows these circuits. The lamp associated with the answering jack acts as a call and clear signal. Clearing may be effected first at either end without causing false clearing signals or removing the engaged test from the multiple before both ends are free.

C.B. Nos 1, 10 & 12 EXCHANGES TRANSFER CIRCUITS FOR TRUNK POSITIONS



16.—TRANSFER CIRCUITS FOR TRUNK POSITIONS. C.B. EXCHANGES.

Special jacks with extra springs are used for the multiple to avoid the release of the transfer 2000-ohm relay, or the operations of the third conductor relay in the trunk cord circuits (see relays marked * in 15) when an engaged test is taken.

THE COLLAPSE OF IRON POLES AT BRIGHTON.

THE Engineering Department of the Post Office has always looked with disfavour upon the policy of erecting iron as an alternative to wooden poles, not only because of the higher prime cost of the former, but also owing to the difficulty in securing an iron pole possessing the necessary rigidity and a sufficiently high factor of safety to withstand the sudden stresses to which overhead telegraph and telephone structures may be subjected.

The wisdom of this view was well illustrated by the breakdown of the iron pole route carrying London trunk circuits, which occurred a few months ago in Ditchling Road, Brighton, and which is depicted in the accompanying photographs.

During winter months, after a heavy fall of snow followed by frost, or one of the severe storms which occasionally visit portions of

these islands, experience shows that a breakdown of communication by means of overhead wires is not an altogether impossible, or even an unexpected, event, but such stoppages are not usually associated with a day in early summer, like that on which this disaster took place.

Before relating the details and circumstances it may not be out of place to briefly review the conditions which existed immediately prior to the incident. The line stood in the kerb of the public footpath, and at the extremities of the section affected the poles,



I.—POLE 317 IS SEEN LYING IN THE FOREGROUND. THE CREOSOTED POLES UNAFFECTED ARE ALSO SHOWN. THE FIRST (No. 316) IS STAYED TEMPORARILY.

numbered 316 and 328, consisted of "stout" creosoted timber, 40 ft. in length, and the present day standard pattern iron, known as "extra stout," 35 ft. long respectively, the eleven intervening ones being "stout" iron, 40 ft. in length, less modern in design, having the wrought iron tubes carried by long fluted cast-iron bases.

Twenty-four 150 lb., four 200 lb., and four 400 lb. copper wires formed the load, and at two points only were horizontal static stresses exerted, viz., at numbers 317 and 318, the angles there being 177° and $178\frac{1}{2}^\circ$ respectively, the corresponding semi-diagonals measuring 4 ft. 6 in. and 2 ft. 6 in., and the spans 200 ft. each, which produced static stresses in the direction of the roadway and at right angles to

its length of 90 lb. and 50 lb. respectively. The height of the resultant point was $30\frac{1}{2}$ ft.

There were no stays, as it was impossible to secure satisfactory staying facilities, a disadvantage peculiar to this type of residential thoroughfare generally, and one which adds considerable force to the contention that the utilisation of the ornamental form of rupingised pole now available, surmounted with a finial, is far more satisfactory than any class of iron pole.

Although calculations indicate that it required the application of



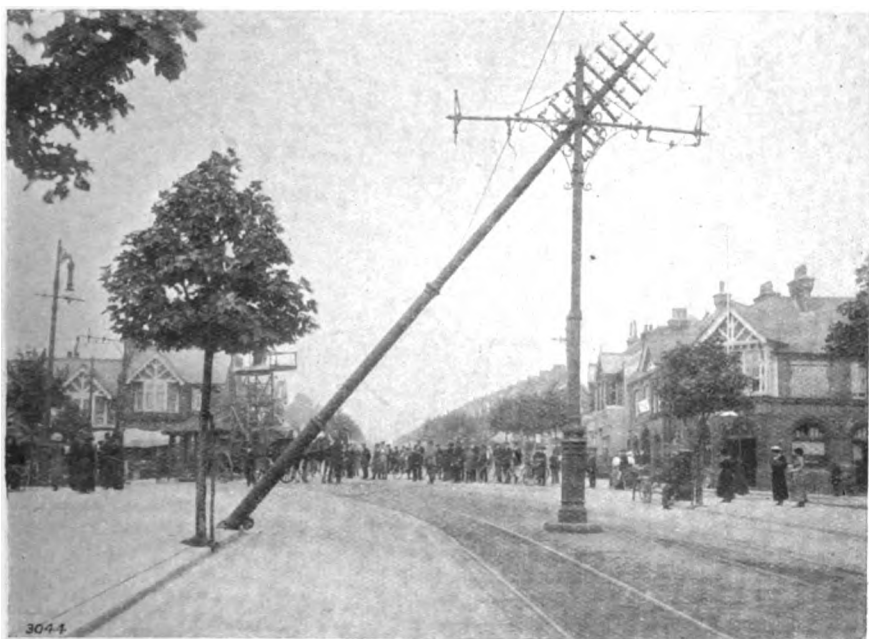
2.—THE NEAREST POLE IS ONE OF THOSE WHICH STOOD NEXT THE POWER CROSSING, SEEN IN 3.

a stress of 17 cwt. at the resultant point in order to fracture the cast-iron base, they, of course, assume the stress to be applied gradually. That the figures must be very greatly modified, when dealing with a load suddenly thrown upon an iron road pole as compared with a wooden one, is clear from a consideration of the effects produced upon, and behaviour of, these two types by the sudden application of a load of much lower value than 17 cwt. which they were called upon to bear in this particular breakdown.

At about 11.0 a.m. the work of loading a motor-driven pantech-nicon, which stood in close proximity to the iron pole, No. 317, adjoining the creosoted one, No. 316 (1), had been completed, and

as the front wheels were turned into the water-channel at an angle to prevent any forward motion of the vehicle, it became necessary to restore them to a position favourable to that motion in order to commence the outward journey. In carrying out this operation a backward movement brought the heavily laden tailboard of the van into contact with the iron pole, fracturing the latter at about 4 in. above the ground line, and causing it to fall across the roadway at right angles to the line of the wires.

The additional stress thereby thrown suddenly upon its neighbour,



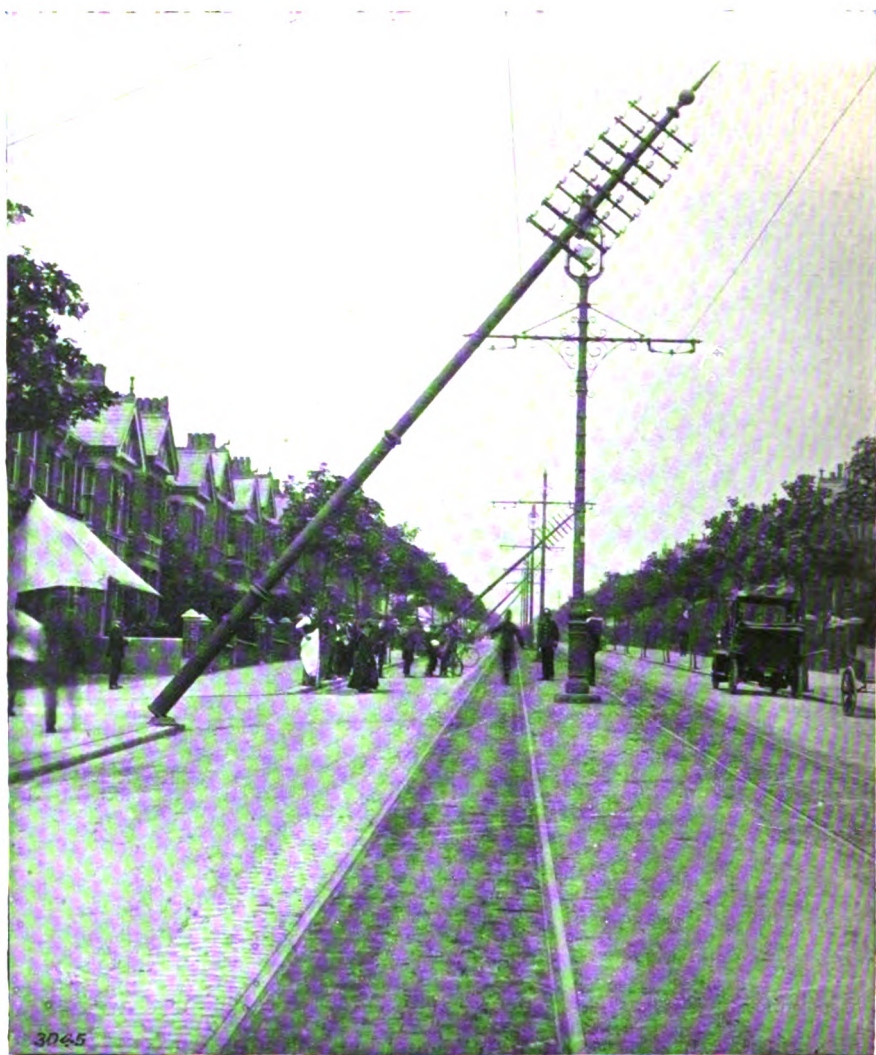
3.—THE POWER CROSSING.

No. 318, resulted in a similar disaster there, whilst the next five poles suffered a precisely similar fate (2).

At this latter point the route crosses the tramway wires, and continues parallel to them. The next four poles, viz., Nos. 324, 5, 6, and 7, also fell, but were prevented from reaching the surface of the road by the tramway trolley wires, which supported them at an angle with the ground of approximately 45° (3 and 4). The breakages occurred with amazing rapidity—the whole of the poles fell within a period of two or three seconds—and were accompanied by loud reports.

The metal at the points of fracture was clean and good grained, and the thickness varied from $\frac{1}{2}$ in. to 1 in. (5). Fortunately, the

road is wide and the residences on the opposite side were not reached by the falling poles, but still more fortunate, and almost miraculous, is the fact that no personal injury resulted, probably because very few people were about at the moment.



4.—POLES 324, 5, 6, AND 7 (NEAREST) SUPPORTED BY TROLLEY WIRES.

It is interesting to note that the creosoted pole numbered 316, dated 1896, adjoining the iron one which was struck by the van (I), withstood in an eminently satisfactory manner the additional stresses thrown upon it, inasmuch as no buckling took place, and the soil around it was disturbed to the extent of $\frac{1}{4}$ in. only. The standard

pattern iron pole at the further extremity of the breakdown, 1 ft. of the lowest wrought-iron tube of which entered the cast-iron base below the ground line, was also unaffected; but in this case the stresses were doubtless considerably reduced, because the falling poles at that end failed to reach the ground, but rested upon the trolley wires.

It goes without saying that no time was lost in dealing with the situation and grappling with the work of removing the *débris*, re-opening the road for traffic, and temporarily restoring communi-



5.—THREE BROKEN BASES.

cation by means of interruption cable, which was telegraphed for. The fact that a large staff of workmen was engaged in the recovery of a relic of the days of telephone competition between the Brighton Corporation and the National Telephone Company in the form of thirty-five miles of aerial cables from over-house routes, which had formed quite a feature in the telephone distribution, was a matter for congratulation, as by despatching motor-cars in various directions fifty or sixty workmen were quickly transported to the scene.

To minimise the period of stoppage of the tramway traffic, that area (3 and 4) was first dealt with, and the service was resumed at 1.30 p.m., a result which was very largely due to the hearty and personal co-operation of Mr. W. Marsh, the Engineer and Manager

of the Corporation tramways, in lifting the poles from the trolley wires and depositing them on pole carts by the use of the winch and tackle associated with the tower waggon.

By 4 p.m. the area shown in 2 had also been treated, and the whole of the material removed.

In the meantime scaffold poles had been inserted in the portions of the cast-iron bases remaining in the ground, in readiness to carry the temporary cable over the side roads. By a happy coincidence a sufficient number of creosoted poles to replace the damaged iron



6.—THE RE-CONSTRUCTED LINE.

ones were lying within easy access, and before the last iron pole had been removed from the roadway two of them had been dressed and erected, one at either side of the power crossing.

The interruption cable was in use for a comparatively short period, as the work of digging out and removing the bases and permanently restoring the line by means of creosoted timber continued night and day without intermission.

The photograph of the reconstructed line (6) was taken exactly seventy-two hours after the breakdown occurred, and immediately prior to the recovery of the temporary cable, which can be seen in position.

C. T. CRISP.

OVERHEAD ELECTRIC LIGHT AND POWER CIRCUITS.

BRITISH POST OFFICE REQUIREMENTS FOR PREVENTION OF CONTACT WITH TELEGRAPHS.*

ELECTRIC light and power circuits are classified by the Board of Trade under four headings, namely :

- (1) Low pressure . . . Not exceeding 250 volts.
- (2) Medium pressure . . . Exceeding 250 volts, but not exceeding 650 volts.
- (3) High pressure . . . Exceeding 650 volts, but not exceeding 3000 volts.
- (4) Extra high pressure . . . Exceeding 3000 volts.

In the case of overhead lines the regulations prescribed by the Board for the safety of the public stipulate that "where an overhead power line crosses, or is in proximity to, any other wire or metal, precautions shall be taken by the Undertakers against contact between a conductor which is not connected with earth and any other wire or metal by breakage or otherwise."

A similar obligation is imposed on electric tramway and trackless trolley Undertakers, and some years ago the Board promulgated definite rules for giving effect to the stipulation ; but, as equivalent rules for electric light and power systems have not been formulated by the Board of Trade, the protection of Post Office plant endangered by such systems has always been made the subject of a "requirement" on the Undertakers, the Postmaster-General's statutory powers being derived from various Parliamentary enactments, general and specific.

During the past few years there has been not only a very great increase in the number of overhead electrical systems, but also marked development in their design, and the Post Office requirements have been materially modified from time to time, with the object of securing effective protection at minimum inconvenience to power undertakers.

Some of our readers would doubtless be interested in an account of the past changes, but the usual consideration forbids such a digression, and it must suffice, therefore, to say that at the present time the policy is to regard overhead power systems as falling into two groups, namely :

- (A) Those worked at pressures not exceeding 650 volts.
- (B) Those worked at pressures exceeding 650 volts.

* The expression "telegraphs" includes both telegraph and telephone wires.

(It will be observed that, with reference to the Board of Trade classification, the former group comprises low pressure and medium pressure systems, and the latter high and extra high pressure systems.)

(A) SYSTEMS WORKED AT PRESSURES NOT EXCEEDING 650 VOLTS.

In the case of pressures not exceeding 120 volts, continuous current, or 60 volts, alternating current, no special arrangements designed to prevent contact with Post Office plant are required.

For other systems worked at pressures not exceeding 650 volts the requirements depend on the design of the power circuit and the relative positions of the two sets of plant. The approved arrangements are as follows :

(1) The disposition of permanently earthed power conductors so that they act also as guard wires.

(2) The provision of independent guard wires.

(3) The use of insulated power conductors supported by earthed bare suspending wires.

(4) The use by the Post Office of insulated conductors for the telegraphs.

Arrangements (1) and (4) are not applicable to alternating current systems of which the pressure to earth exceeds 250 volts.

The following details indicate the requirements under each of the first three arrangements :

(1) Earthed Conductors Arranged to Act as Guard Wires.

The earthed or neutral conductor to consist of two copper wires, not lighter than No. 11½ S.W.G., each of which will be earthed at only one point—that is, at the generating station or transformer.

Both wires of a split earthed conductor or split neutral conductor must be connected to earth permanently, and the electrical continuity of both wires must be maintained.

(a) *Crossings other than Diagonal Crossings : Telegraphs Uppermost.* The earthed wires to be erected above the potential wire or wires, as shown in—

1 for 2-wire systems.

2 for 3-wire systems.

3 and 4 for 3-phase 4-wire systems.

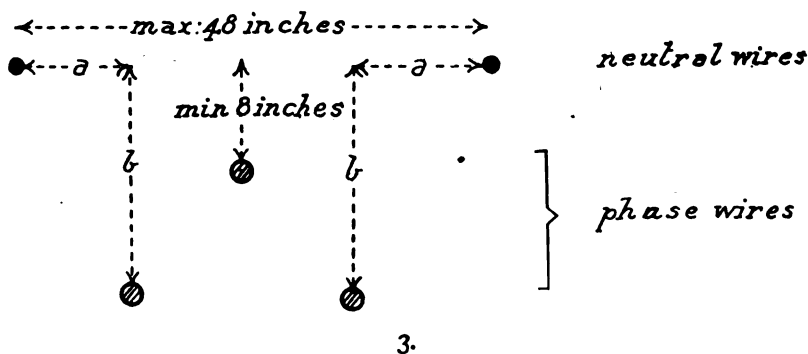
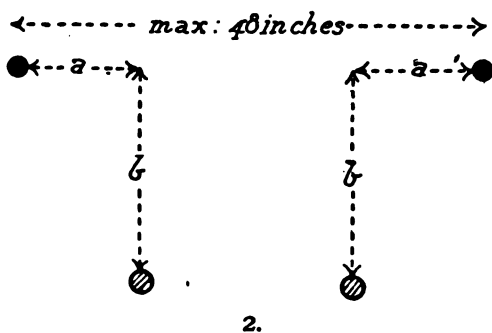
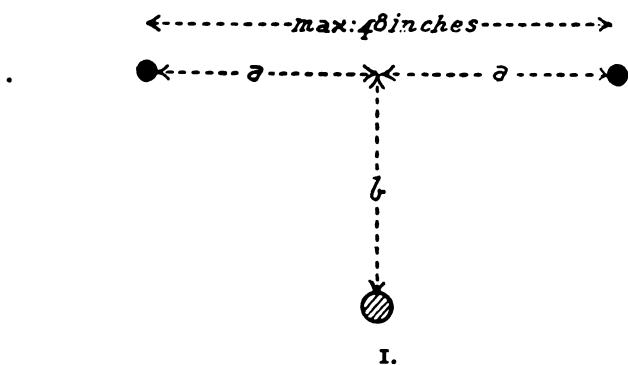
In each case it is necessary that—

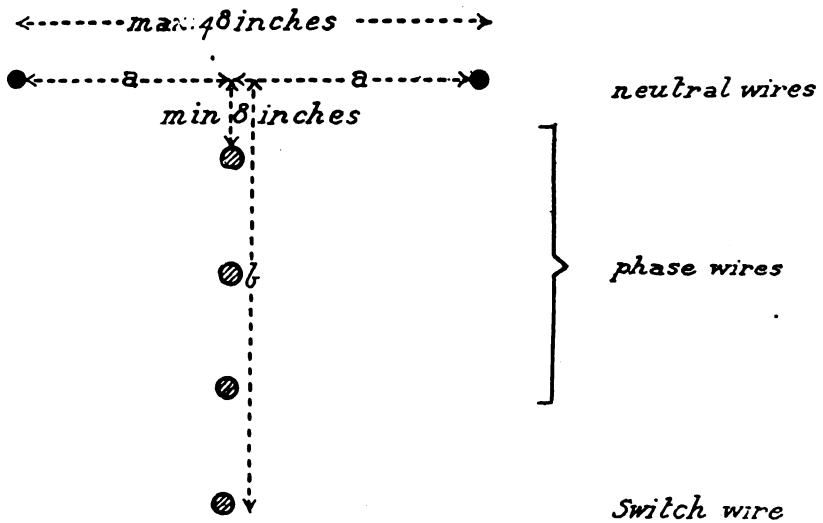
The minimum vertical distance “*b*” between the *highest* potential wire and the horizontal plane in which the neutral or earthed wires are carried shall be 8 in. ;

The maximum distance between two adjacent earthed wires

used as guards shall be 48 in., and when the conditions are such that the distance between two earthed wires used as guards would exceed 48 in., a third earthed wire shall be erected midway between the other two ;

The overlap " a " of the neutral or earthed wires shall be not less than one-half the vertical distance " b " between the lowest power wire and the horizontal plane of the guard wires.





4.

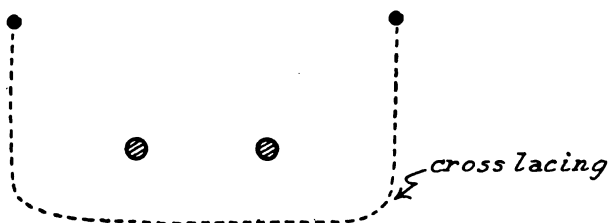
(b) *Crossings other than Diagonal Crossings: Power Circuit Uppermost.*—The earthed wires may be arranged as shown by “A,” “B,” or “C” (5), but if they are erected below the potential wires the overlap must be greater than the vertical separating distance; that is, “a” must be greater than “b.”

At intervals of not more than 6 ft., for a distance of 18 ft. on each side of the crossing, the earthed wires are to be connected by cross-wires (of the same gauge) passing under the potential wires (see “D”); but if on either side of the crossing there is a power pole within 18 ft. the cross-lacing need not be extended beyond that pole.

(c) *Diagonal Crossings.*—For a diagonal crossing, 1, 2, 3, 4, or 5 applies, as the case may be, and, in addition, the earthed wires must be cross-laced at intervals of 6 ft., as shown in 6, for such a distance as may be required by the Post Office Engineer.

(d) *Telegraphs Parallel to Power Circuit.*—In the case of parallel lines, protection is required when the vertical distance between any telegraph or telephone wire and any power wire other than the earthed wires, exceeds the horizontal distance between them (see 12).

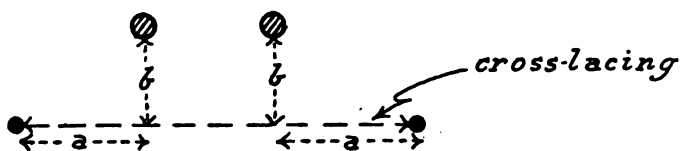
If the telegraphs are uppermost the case is treated as a crossing, and 1, 2, 3, or 4 applies according to the type of power circuit involved; if the power wires are uppermost 5 applies, but the cross-lacing must be continuous throughout the section of line affected.



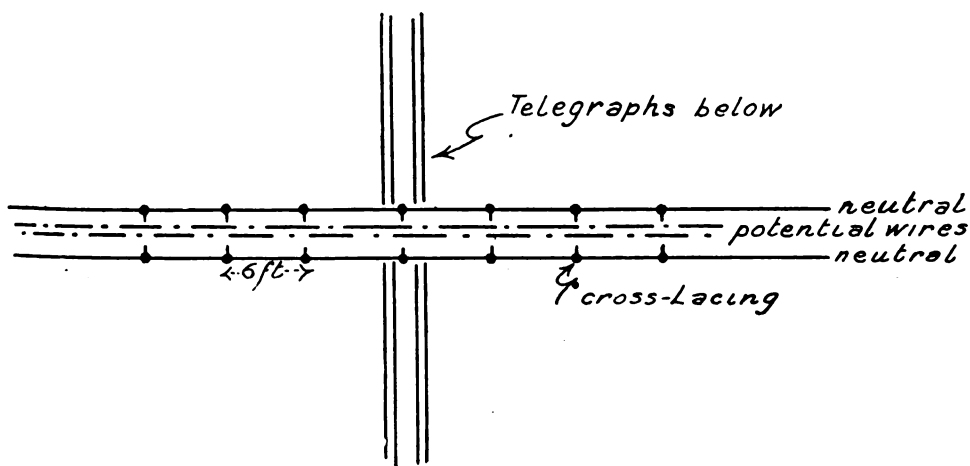
"A"



"B"

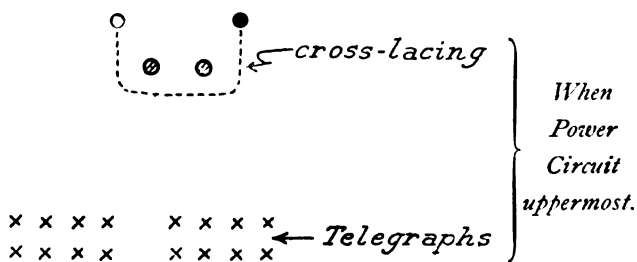
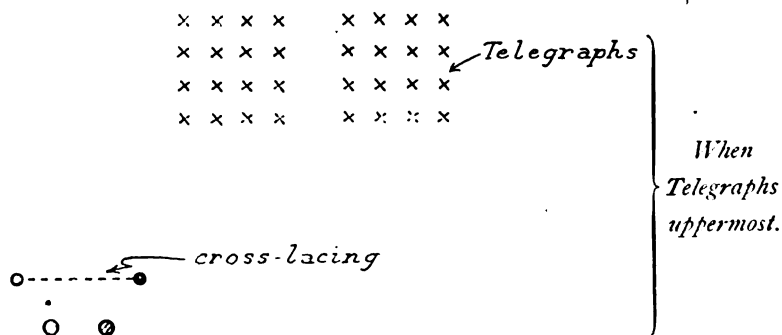


"C"



"D"

5.



6.

(2) Independent Guard Wires.

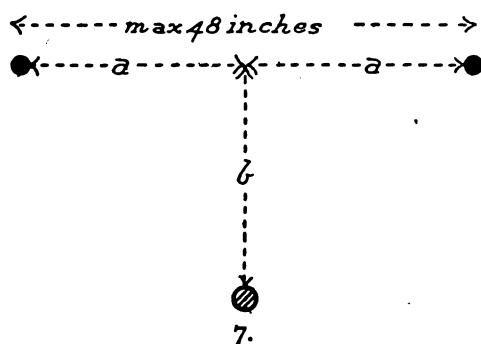
Guard wires must be, in general, of galvanised steel, minimum gauge, No. 8, S.W.G., or $\frac{7}{16}$ S.W.G. ; but in manufacturing districts, where such wire is liable to rapid corrosion, the use of bronze or hard drawn copper wires of equivalent strength is required.

The supports for the guard wires must be rigid and of sufficient strength for their purpose.

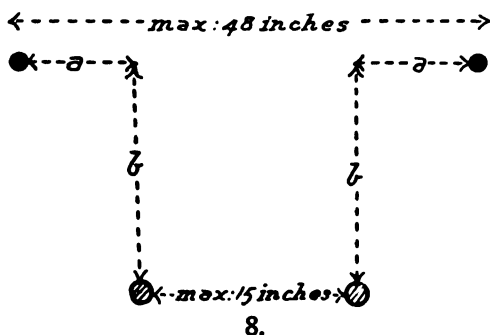
Each guard wire must be securely bound in or terminated at each support and must be well earthed at both ends, and at intervals of not more than 200 yards.

Each earth connection must be made by means of a permanent connection to a water main, or by means of a substantial cast-iron earth plate fitted with a strand of copper wire of sufficient length to admit of the joint being made above ground. Periodical tests should be made by the undertakers to prove that each earth connection is efficient.

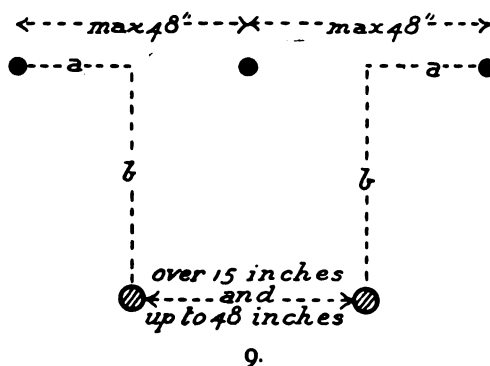
(a) *Crossings other than Diagonal Crossings: Telegraphs Uppermost.*
7 applies when there is one power wire, two guard wires being required.



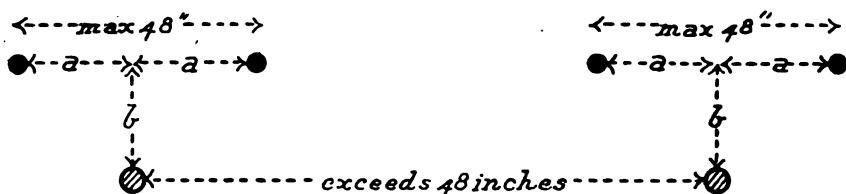
8 applies when there are two power wires not more than 15 in. apart, two guard wires being required.



9 applies when there are two power wires and the distance between them exceeds 15 in., but does not exceed 48 in., three guard wires being required.



10 applies when there are two power wires and the distance between them exceeds 48 in., four guard wires being required.



10.

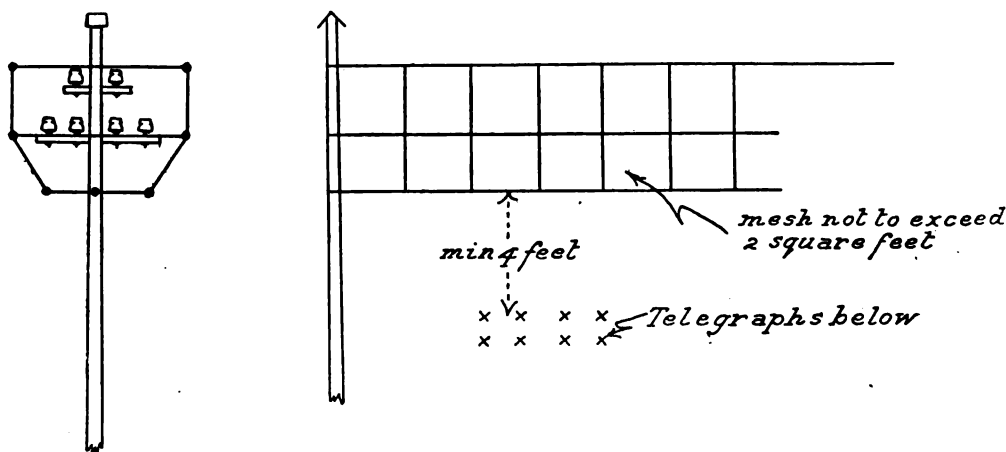
In each of the four cases it is necessary that—

The minimum vertical distance “*b*” between the highest power wire and the horizontal plane in which the guard wires are carried shall be 8 in. ;

The maximum distance between two adjacent guard wires shall be 48 in. ;

The overlap “*a*” of the guard wires shall be not less than one half the vertical distance “*b*” between the lowest power wire and the horizontal plane of the guard wires.

(b) *Crossings other than Diagonal Crossings: Power Circuit Uppermost.*—Earthed cradle guards (II) will be erected on the power circuit supports.



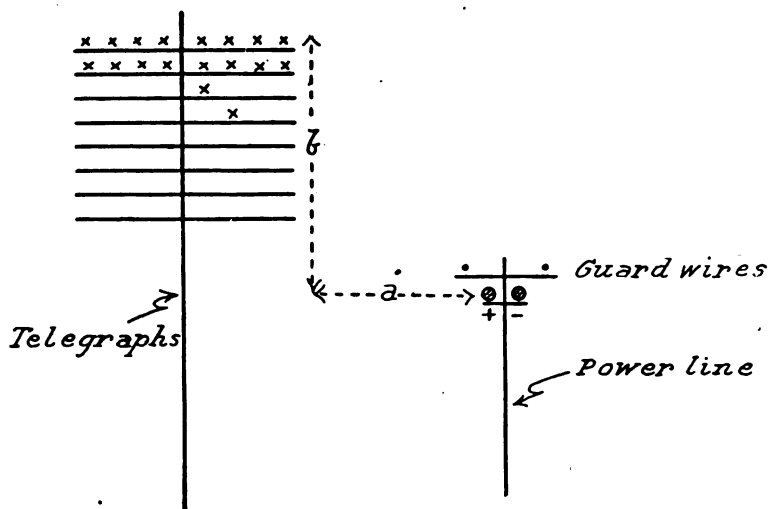
11.

(c) *Diagonal Crossings.*—For a diagonal crossing 7, 8, 9, 10, or II applies as the case may be, and, in addition, when the telegraphs are uppermost, the guard wires will be cross-laced at intervals of 6 ft. for such distance as may be required by the Post Office Engineer.

(d) *Telegraphs Parallel to Power Circuit.*—In the case of parallel lines, protection is required when the vertical distance between any telegraph or telephone wire and any power wire exceeds the horizontal distance between them (12).

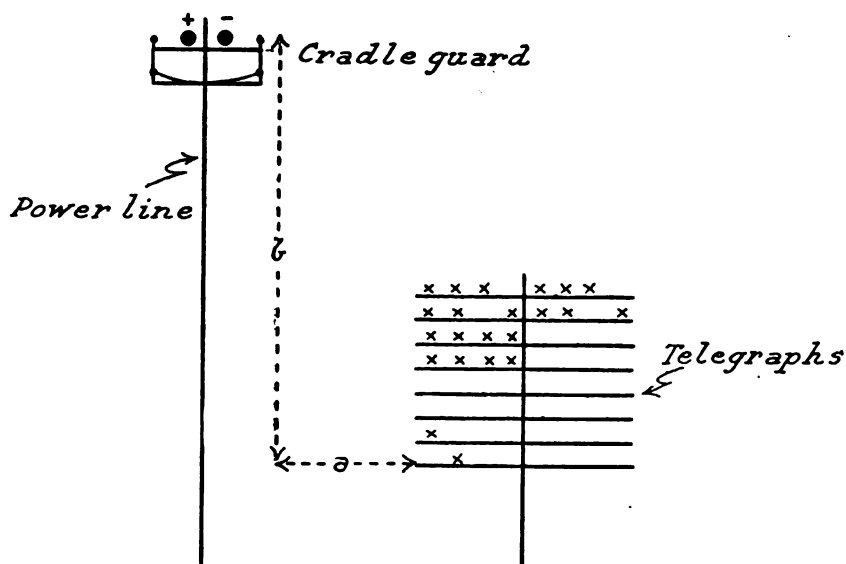
If the telegraphs are uppermost the case is treated as an ordinary crossing, and 7, 8, 9 or 10 applies according to the circumstances; if the power wires are uppermost a cradle guard is necessary, and II applies.

Telegraphs uppermost



Guard when a is less than b

Power line uppermost



Guard when a is less than b

(3) Insulated Power Conductors.

Covered conductors, the covering not being merely braid or bra and rubber, will be accepted as sufficient protection if they are supported by bare wires efficiently earthed at both ends.

In the case of low pressure continuous current systems, *i. e.*, not exceeding 250 volts, earthed supporting wires are not required if the conductors are covered with a durable weather-proof coating approved by the Post Office.

General Conditions.

The minimum clearance between any part of a low or medium pressure power line and a Post Office line must not be less than 4 ft., and if the Post Office line is not fully developed such additional clearance must be provided as will meet the ultimate conditions.

Stay wires crossing above or below power circuits are regarded as telegraphs.

All guard wires and guarding arrangements must be efficiently maintained by the owner of the power circuit.

In exceptional cases, such as in very exposed positions or for heavy telegraph lines, the normal arrangements may be inadequate, and, if so, special conditions are imposed.

It may be added that the Engineer-in-Chief to the Post Office is always willing to consider representations from power undertakers in regard to alternative methods of providing satisfactory protection for the telegraphs.

(B) SYSTEMS WORKED AT PRESSURES EXCEEDING 650 VOLTS.

In the case of these systems the standard of protection aimed at may be described as "absolute," *i. e.*, the object is to eliminate all risk of mechanical contact. It is, therefore, the practice to require that at no point shall the separating distance between the overhead power line and Post Office overhead plant be less than one and a half times the height of the highest wire on either line at that point, plus, as a rule, any difference in the ground level of the two lines. This requirement involves that at actual crossings of the two systems, one or other of the lines must be placed underground, and if the Post Office line carries long-distance wires its retention is imperative, and the power undertaker has, therefore, to provide underground cable; if, however, considerations of efficiency permit, arrangements are made to facilitate the power undertaker's work by inserting a section of underground work in the Post Office line.

LETTER-STAMPING MACHINES.

By A. B. EASON, M.A.

SOME information concerning motor-driven machines in use in the British Post Office may prove interesting to the readers of the JOURNAL. This article describes briefly (1) the purpose of such machines, (2) the chief features of the machines, and (3) the introduction of various types of machines to the Post Office service.

(1) The purpose of the letter stamping machines is to cancel the postage stamps on letters; to stamp the words "Paid $\frac{1}{2}d.$," etc., on correspondence, the postage on which has been prepaid; or to stamp envelopes containing imitation type-written circulars with a triangular die bearing the code letters of the office of posting, *e. g.*,



At certain offices other particular dies are in use for special purposes, or for use with certain types of correspondence. At post offices where the volume of correspondence does not exceed, say, 12,000 letters daily, stamping is done by hand.

The approximate rates of stamping are given in the following table:

Method of stamping.	Letters per minute.		Letters per hour, approximate.
	Average for short periods, 1 to 5 minutes.	Average for long periods, $\frac{1}{2}$ to 1 hour.	
By hand	100	75	4,500
By hand-driven machine	400	200	12,000
By motor-driven machine	500	400	24,000
By high-speed motor-driven machine	900	600	36,000

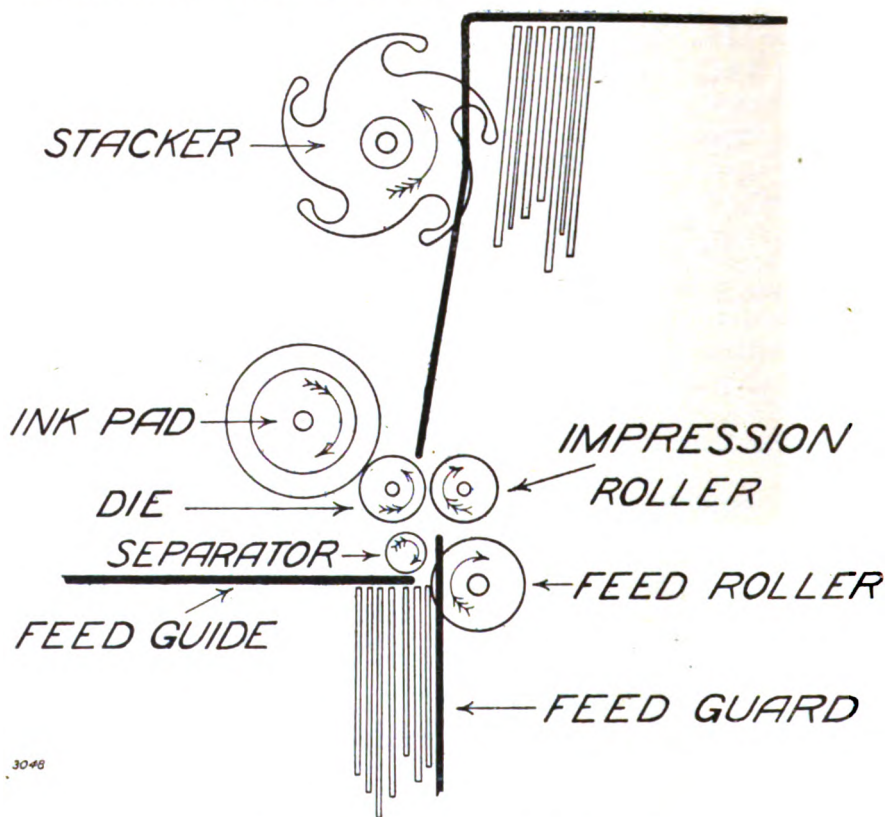
These figures are given only for the purpose of a general comparison, as any individual machine may in practice be made to give quite different results, depending upon the expertness of the men in charge and the type of letters passing through the machine.

(2) *Chief mechanical features of the machines.*—The important parts of the machine are the drive and gearing, the feeding, the obliterating, the separating, and the stacking mechanisms. The relative positions of these are shown diagrammatically in 1 and actually in 3.

The driving mechanism calls for little comment. A chain drive, similar to that of a bicycle, leather belting, or gear wheels with machine-cut teeth, are fitted to convey the power from the hand wheel to the various mechanisms in hand-driven machines; and from the electric motors to the mechanisms in power-driven machines.

The feeding mechanism is arranged with one vertical plate (the

feed guide) against which rest the edges of the batch of letters to be stamped, and a vertical plate, at about right angles to this (the feed guard) through which project the feed wheels fitted with rubber rollers; these carry the letters forward into the machine. In some machines the horizontal surface on which the letters rest is made of leather belting, which is made to move in the direction that the letters are required to take to reach the stamping mechanism.



I.—RELATIVE POSITION OF MECHANISM.

The function of the separating mechanism is to allow only one letter at a time to pass forward to the die which makes the impression for cancelling the stamp. This mechanism is very important, because every letter which is not stamped must be re-sorted and stamped by hand, or taken back to the machine and passed through it a second time. The separating mechanism works on the front of letters, while the feed rollers work on the back.

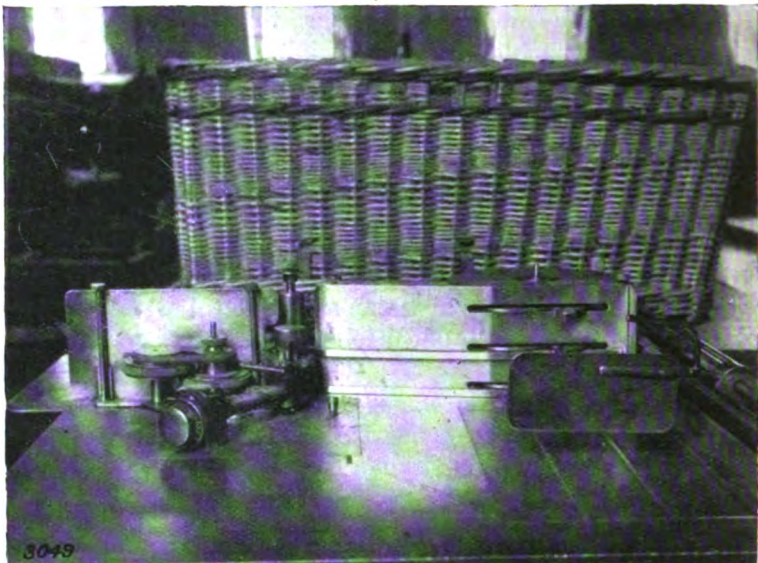
The separator in the Columbia machine consists of a rubber pad and steel spring pressing against the letters entering the machine. In the Krag machine it consists of a steel wedge kept pressed

against the letters by a spiral spring; in other machines it consists of a rubber roller rotating in the same direction as the feed rollers, but on the opposite side of the letters, so that it tends to drive the letters out of the machine. The principle of the mechanism is easy to understand. Suppose two letters tend to enter the machine at the same time; one is driven forward by the feed rollers, the other is driven backward or held back by the separator. If the friction between the letters be great, or the friction between the separator and the letter small, the driving force of the feed rollers on the first letter may be able to overcome the retaining force on the second letter and carry it through the machine; in which case it receives the obliterating stamp, while the first letter passes through the machine with the stamp uncanceled and will be counted as a "miss."

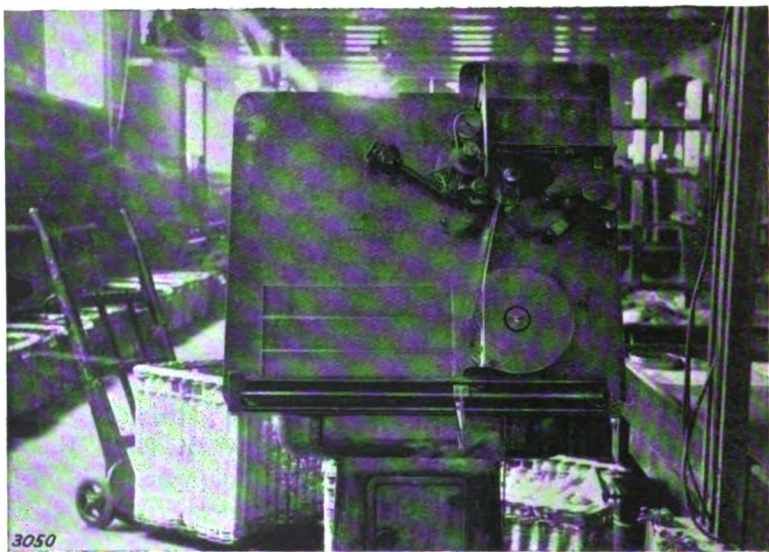
The obliterating mechanism and die.—This mechanism consists of the die engraved with the name of the town, date, and time of posting, or engraved with "Paid $\frac{1}{2}d.$," or other form of lettering; and usually includes straight or wavy lines, the whole giving an impression about 2 to 3 in. long, so that some portion of the impression will be sure to obliterate the postage stamp. In some foreign countries, instead of the wavy lines, advertisements of some sort are used. The dies of Krag and Bee machines rotate continuously, so that the obliteration appears the full width of the letters; the die of a Columbia machine rotates continuously, but it stamps letters for only a portion of its period of rotation, so that a single impression is given on each letter; the letter is held by a stop in front of the blank part of the die until the engraved portion is just about to touch the letter. The stop then draws back, allowing the letter to go forward and the impression to be made. In the Universal and Hey-Dolphin machines, the die rotates once for each letter, which hits a "trip finger" as it comes forward and puts the die in connection with a continuously rotating spindle. This spindle carries the die round once and then becomes disconnected until another letter hits the trip finger. A counting mechanism records the number of revolutions of the die, and shows at once the number of letters which have been obliterated. The total number of letters which have passed through the machine must include those that have "missed," *i. e.*, those that have received no obliteration.

Opposite the die is the impression roller, which keeps the letter pressed against the die. A strong spring is required for this purpose, as the impact of a letter that is being driven forward at a high speed would otherwise drive the roller away from the die, and thus allow the letter to pass without receiving an impression or at least only a faint obliteration.

Stacker.—The function of the stacking mechanism is to place the



2.—Krag Machine. Motor-driven. Front View.



3.—Krag Machine. Motor-driven. Top View.

letters, after stamping, in good order ready for removal to the sorting tables. The "stacker" consists of rotating arms, which change the direction of movement of the letter as it comes from the die to a direction at right angles to its plane and its previous travel.

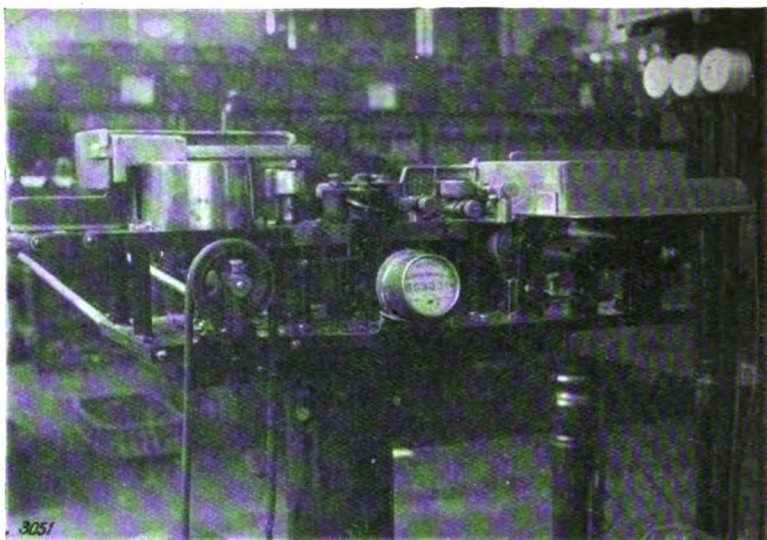
Machines in use.—After the letters posted by the public are received in the sorting office they are "faced," that is, placed in batches with the address upwards, the stamp being on the right hand top corner. During the process of facing, the bulky packets and specially long letters are sorted out for stamping by hand, while the suitable letters are taken to the stamping machines. Of these letters there are always a small number which pass through without being obliterated, due either to the separating mechanism having failed to act or to imperfect feeding. The stamp may not have been in the usual place on the envelope, or the letter has been wrongly faced with the back instead of the front uppermost. The percentage of letters missed due to failure of the separating mechanism varies from $\frac{1}{2}$ per cent. to 4 per cent. ordinarily. In exceptional cases, when the machine is out of adjustment and the feeding is not correct, this percentage has been known to rise to 20 per cent. Normally, it would be 2 per cent. to 3 per cent., decreasing to 1 per cent. under favourable conditions. The percentage of letters fed through stamping machines which have the stamps in the wrong place varies from 0 per cent. to 2 per cent.

The percentages of wrongly faced letters is not known.

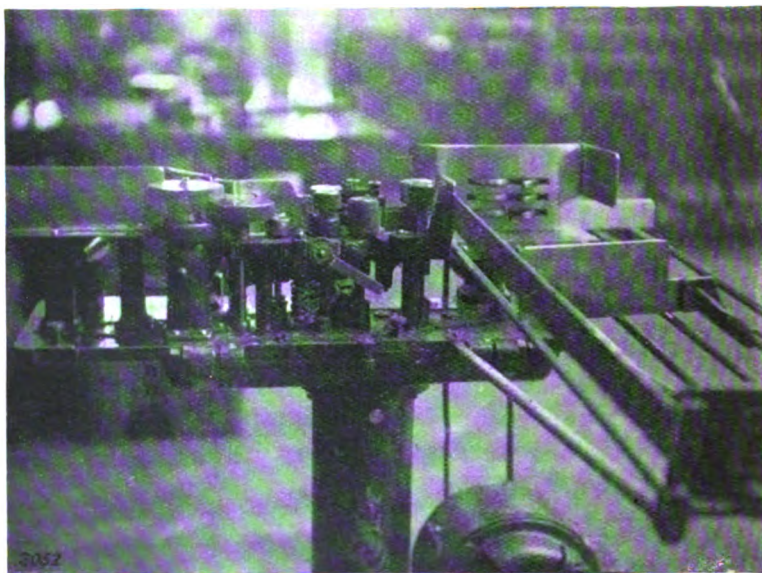
When comparing different types of machines, the relative merit of each of the above-mentioned mechanisms has to be borne in mind and studied; the only two points which are capable of quantitative comparison are the power required to drive the machine and the number of "misses." In testing a particular machine for "misses" under various conditions as to speed, or types of feed rollers, one officer should feed the machine during all the tests, as the variations due to feeding by different officers will usually outweigh the variations due to alteration of conditions. When making comparisons of different machines, a large number of tests should be taken with various officers feeding each type of machine in turn, and the average of the results taken. A very skilled feeder can produce very good results with a machine in good adjustment, but for test purposes average skill should be employed as in ordinary practice.

The machine should be capable of giving good results even when fed by unskilled men, as any officer may be called upon to perform the duty.

(3) There are eight types of machines in use in the Post Office, viz.: Columbia, Krag hand-driven, Krag motor-driven (2 and 3), Bee, Universal Model C (4 and 5), Universal Model D, Hey-Dolphin Flier, and Hey-Dolphin Model M. Of these types the first machine



4.—UNIVERSAL MODEL C MACHINE. FRONT VIEW.



5.—UNIVERSAL MODEL C MACHINE. BACK VIEW.

installed was the Columbia (No. 46), which was put into use in 1902 in the old General Post Office, East. The first Krag motor-driven machine (No. 24) was installed in the same office in 1904. The first hand-driven Krag was tried at Chelsea in 1907, and after alteration was transferred to Kilburn. The first Bee machine was installed in King Edward Building, London, in 1912. Universal and Hey-Dolphin machines were on trial in 1911, but the first Universal machines purchased were placed at King Edward Building, London, St. Albans, and Doncaster in December, 1913; and the Hey-Dolphins at Birmingham, Belfast, Lincoln, Rochdale, and Wallasey in December, 1914. The first Universal Model D was placed at Croydon, and the Hey-Dolphin Model M at Canterbury. Various other types of machines have been tested recently, but have not been put into permanent use.

The attached list shows the distribution of machines to date, and includes spare machines held for use in cases of emergency at any office.

This year, owing to the concentration of troops at certain small towns, quite a number of machines, which had been ordered to meet prospective ordinary demands, were allocated at once on delivery to meet the special war conditions. Some machines were also sent over to France for the Army Postal Service.

Stamping Machines installed, November, 1915.

District.	Motor-driven.	Hand-driven.
Ireland	5	6
Scotland East	4	4
„ West	4	12
Northern	6	3
North-Western	11	6
„ Eastern	13	5
„ Midland	15	7
South Lancs.	14	18
North Wales	10	9
South Wales	9	2
„ Western	9	5
„ Eastern	9	3
„ Midland	8	8
Eastern	4	7
London	61	81
Miscellaneous	4	5
Total purchased	186	181



EDITORIAL NOTES AND COMMENTS.

TRANS-ATLANTIC AND LONG DISTANCE WIRELESS TELEPHONE DEMONSTRATIONS.

SOME very interesting reports of the recent successful wireless telephone experiments between the United States Naval Radio-telegraphic Station at Arlington and various long distance receiving stations have been published in the current technical press of America. On September 29th, speech was successfully transmitted in one direction from Arlington to Mare Island, California—a distance of approximately 2500 miles—and the same speech was overheard at Pearl Harbour, Honolulu, a distance of 4900 miles. On October 21st the experiments were successfully repeated between Arlington and the Eiffel Tower Station in Paris. These results must be regarded as a great step forward in the art of wireless telephony, but to those actively engaged in experimental research the result is by no means unexpected. A large number of experimentalists have undoubtedly been working along parallel lines since the characteristic behaviour of vacuum bulbs containing a hot and a cold electrode became known. It has been publicly stated that but for the war the Marconi Wireless Telegraph Company would have carried their trans-atlantic wireless telephony experiments to a successful conclusion.

It is inferred from matter already published that the success of these experiments is principally due to the employment of the so-called vacuum valves or gas discharge relays, both at the sending and receiving stations. Prof. Fleming, a good many years ago,

published the results of some of his investigations on a vacuum bulb containing a hot and a cold electrode, and a number of developments have since been recorded in which a grid or screen has been interposed between the electrodes. Vacuum valves containing these elements have been used for a variety of purposes, *e.g.*, rectifiers of feeble hertzian radiation, telephone relays, and oscillators for changing direct current into rapidly alternating current. The promoters of these long distance experiments have not, so far as is known, made public the details of the apparatus and connections used, but the various comments of American physicists throw some light upon the apparatus used. Prof. Goldsmith is quoted as having stated that the success of this experiment is largely due to the employment of an improved form of vacuum valve, and that Prof. Fleming's invention is the keystone of the arch on which this successful demonstration is supported. The principle of the Fleming valve is also said to have been used by the American Telephone and Telegraph Company as a repeater in the demonstration of long distance telephony over land lines between New York and San Francisco recently.

Dr. Lee de Forest is also credited with having said that "Not one wireless man out of fifty is not aware that this extraordinary long distance wireless reception is possible only by use of the audion detector and audion amplifier at the receiver," and, as regards the transmitter, "It is less generally known that the large audion bulb is a generator of high frequency energy. It is the device which makes it possible to telephone by wire to San Francisco."

From the various comments on these experiments which have appeared it is concluded that the high frequency current for charging the transmitting antenna is generated by a large number of oscillation valves instead of by the older methods, *e.g.*, arc-in-hydrogen, high frequency spark, or the Goldsmith alternator. There is no reason to anticipate any limit, beyond that of space accommodation, to the number of such oscillation valves that could be connected in parallel, and there appears no practical difficulty in controlling the operation of these valves by a master microphone taking a small amount of energy in a local relay circuit. Such an arrangement removes the difficulty previously experienced whenever a group of telephone transmitters was employed to directly control the whole power in the antenna. At the receiving end no novel feature would be needed, because the apparatus previously developed for wireless telegraphy have been found efficient receivers of wireless telephone radiation.

The employment of the oscillation valve at the transmitting station greatly simplifies the connection between the ordinary telephone system and a powerful wireless telephone station, for the wireless transmitter itself is in many respects similar to the gas

discharge telephone relay ; the connection need not, in fact, involve mechanical movements, such as the diaphragm of a telephone receiver. Some such arrangement was doubtless employed to enable the President of the American Telephone and Telegraph Company to speak from his office in New York over the land lines to Arlington and thence by wireless to Mr. Carty, the Chief Engineer of the Company, at Mare Island. The wireless transmission in these experiments was conducted only in one direction, the replies coming back over the ordinary land lines. For transmission over such a distance, even with a very large antenna, a large amount of power would be required, say 50 to 100 kilowatts, and to control such power a large number of oscillation valves would be required. The expense of duplicating all this equipment doubtless explains why the experiments were limited to transmission in one direction, and it also explains the views expressed by Mr. Bancroft Gherardi, one of Mr. Carty's principal assistants. He is quoted as having stated that he expected wireless telephony would form a most important adjunct and extension to the existing schemes of communication, but for many reasons wireless telephony can never take the place of wire systems although it may be expected to supplement them in a useful manner. He further stated that wireless telephone systems are subject to serious interference from numerous conditions, atmospheric and otherwise. In this connection, however, it is interesting to note that Prof. Pupin, of Columbia University, and also Mr. Nikola Tesla announce that they have discovered means of eliminating the effect in wireless telephone systems of the so-called atmospheric disturbances. Such disturbances have undoubtedly constituted a very grave obstacle in the past, and if the claims reported are actually realised another step forward in a very wonderful development has been achieved.

AMERICAN COMMENTS ON THE REVISED TELEGRAPH TARIFF.

The decision of the House of Commons to abandon temporarily—it may be permanently, for undoubtedly there are lean years ahead—the sixpenny rate for inland telegrams has evoked considerable comment in the telegraph and telephone press of the United States. In not a few instances the criticism ignores entirely the abnormal conditions that exist in this country, and hails the rise in rates as merely another glaring example of the inability of the State to run any business successfully. The following paragraph, published in one journal and considered worthy of quotation in another, is reproduced here as an example of how, in the name of the dismal science of economics, figures can be utilised to suit the theories of a particular school :

“ENGLISH TELEGRAPH RATES.—Telegraph rates in Great Britain “are to be raised 50 per cent. by the British Government, which “owns and controls the telegraph lines in that country. This is one “of the beautiful results of government ownership of telegraph lines. “What would the public do to us if we raised American telegraph “rates 50 per cent.?”

For the information of those of our readers who are not already acquainted with the fact, it is necessary first of all to mention that in the United States there has been for some time past much controversy on the question of State purchase of the telegraph system, and even of the telephone system. The arguments in favour of State ownership are identical with those which were current in this country from 1890 to the termination of the National Telephone Company's license on December 31st, 1911. The counter-arguments of the opponents of State ownership are similar to those advanced by supporters of the expired telephone *régime* in this country, reinforced by the alleged failure of the British Post Office to make a profit on the telegraph system.

We do not propose at this stage of our history to attempt to demonstrate to our American *confrères* the advantages to the community (including the staff of the joint undertaking) which have accrued, and continue to accrue, from State ownership; further, as regards the telegraph system, we are not prepared to admit that during the last thirty years the policy of the Government has been to make a profit on the service; at a later date it may be possible to deal fully with these points, for we realise that there still remains much to be said—and said with advantage—in the cause of State ownership.

Our present purpose is to point out to our contemporaries:

Firstly, that Great Britain is at war;

Secondly, that the increased tariff for telegrams is due to that war;

Thirdly, that the increase is not 50 per cent., but the substitution of a minimum charge of 9*d.* for that of 6*d.*, the remainder of the tariff being unaffected; in other words, a war tax of 3*d.* per telegram has been imposed.

In this country we have benefited greatly in the past by a knowledge of the experiences of telegraph and telephone men in the States, and we have reason to believe that there is a substantial entry on the other side of the account. Many of us watch with keen interest the rapid progress in electrical matters which seems only natural to the land of Graham Bell and Edison, Steinmetz and Tesla, Pupin and Carty, and many others whose names to us are practically “household words,” and we look forward to a time when the acquisition of fuller knowledge shall be accelerated. Pending the advent of that happy day, we do not ask our *confrères* to abstain

from adorning their domestic contentions with illustrations drawn from our history, but we do ask them to co-operate with us in our endeavour to give publicity only to established facts and sound deductions.

THE BALANCING OF DUPLEX CIRCUITS.

The Editor, THE POST OFFICE ELECTRICAL ENGINEERS' JOURNAL.

MR. HASE's question and Mr. Morice's answer (in Part 3 of current volume) raise a number of other interesting questions. It is true, as you remark, that a "skilled man has not much difficulty in securing a good working balance," if such a system as hand-worked Morse or slow-speed Wheatstone is in mind.

Balancing a duplex or quadruplex circuit requires a knowledge of the composition of the circuit, shrewd guessing, and intelligent manipulative balancing. I do not think one can calculate a capacity balance for a long distance circuit; it may be possible, but I know of no one confident enough of the method to adopt it.

Mr. Morice's explanation, following Mr. Hase's form of question, gives the total capacity for the balance, but it must not be assumed that that capacity in one lump would balance the circuit. I remember on one occasion, whilst trying to develop a systematic method of capacity balancing, finding that with the capacity in one lump 13 mfs. was too little and 14 mfs. too much, so that apparently something between the two, divided up, might have balanced, but on dividing the capacity into three parts, to time the discharges, I found an aggregate of 7.25 mfs. gave me a practically perfect balance—good enough for high-speed Wheatstone working. After that, I never tried capacity in one lump first—it would have been a waste of time to do so.

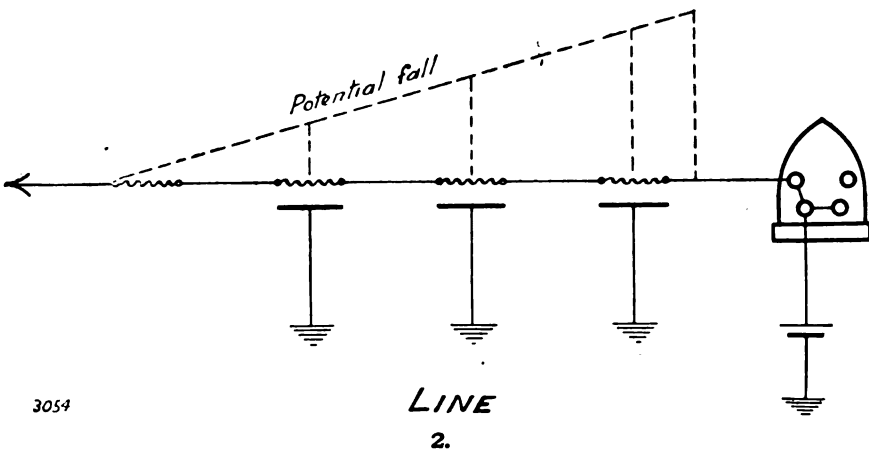
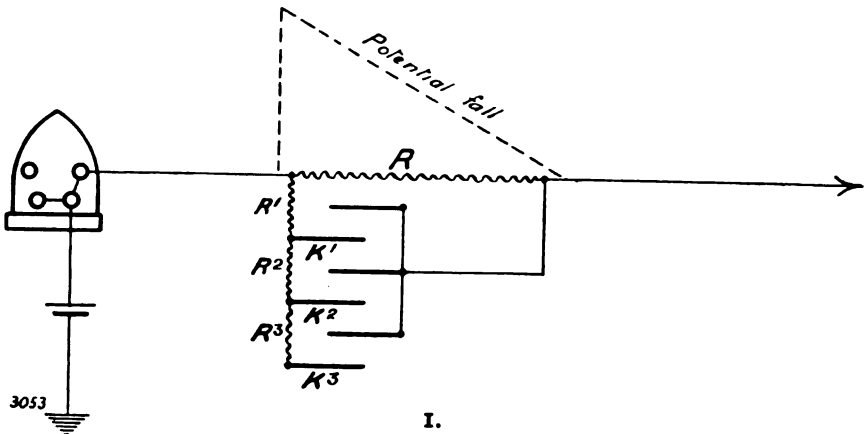
Systems for capacity balancing used to be secret processes, and were very jealously guarded; to-day, however, although there are quite a number of systems in use, the advocates of them are quite willing to divulge and to discuss the merits of the various processes. It is a curious fact that two men can get, by different processes, different balances, and yet with apparently equally good results.

My reflection on capacity balancing has led me to condemn the present method of joining up the apparatus in the compensation circuit as scientifically incorrect and unnecessarily difficult from a practical balancing point of view. According to the standard diagrams, the compensation circuit should be joined up as follows (see 1).

Compare this with a line which may be represented by 2.

There is to me one vital mistake in the compensation circuit as

at present arranged, and that is, all the capacity discharges have a uniform voltage—usually a comparatively high one—behind them. The discharges from line, however, have varying voltages behind them dependent on that part of the line from which the discharge proceeds. The capacity multiplied by voltage may be equal in both



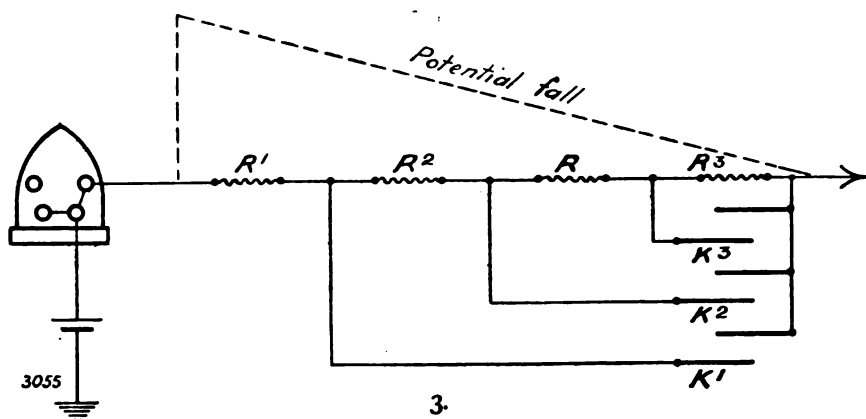
cases, and so satisfy a mathematical equation, but in their physical aspects the results obtained are far different.

Without any additional apparatus the compensation circuit can be made to more closely represent the line conditions by re-arranging as follows (3):

We now see that there are diminishing voltages across the condenser. This is what is required. At the same time another point has incidentally been gained, that is, the line resistance, if wisely

distributed, has also given the necessary retardations for the condenser discharges. These should not require further alterations. It is then left to distribute one third of the calculated capacity of the line (if you know it) between K_1 , K_2 , and K_3 . Arranging this distribution is where the trial and error method, using upward and downward kicks on the galvanometer or dots on the Wheatstone-slip, commences. The best way to proceed is to make changes giving very pronounced indications, and then, having found the guiding signals, to use them with intelligence.

I think, and my opinion has been supported theoretically and confirmed practically by others, that the balances obtained when the



apparatus is joined up as in 3 are more stable than those obtained when the apparatus is joined up, as in 1.

Yours faithfully,

E. V. SMART.

East External Section,
London.

One of our readers, presumably a Colonial member of the Institution, has been kind enough to send us the following extract from the *Johannesburg Star* of September 11th :

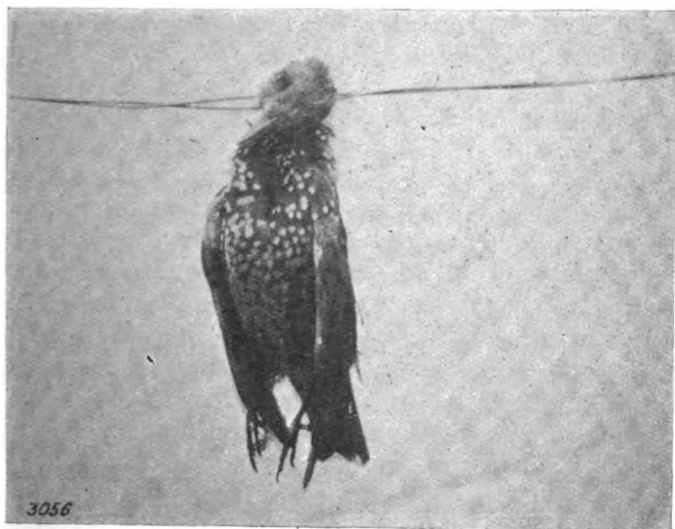
“The following has been officially communicated to the press by Defence Headquarters, Pretoria.

“Major Norman Harrison, A.M.I.E.E., Engineer-in-Chief of the Union Postal Telegraphs, who has held the position of Director of Army Signals for the past twelve months, has been appointed to command the Royal Engineer Divisional Signal Company which forms Part of the South African Oversea Expeditionary Force.”

Our correspondent will be interested to know that Major Harrison is now in this country, and is looking very fit.

A TWISTED PAIR: *The Result of Interfering with the Postmaster-General's Plant.*

The bird had evidently flown against the wires and been flung head-over-tail several times by the momentum of its flight. The wires are the A and B lines of a subscriber's circuit near Datchet, and are of 40 lb. bronze. We are indebted to Mr. J. H. Thow, Reading, for the photograph of this most remarkable "fault."



A Contractor's Reasons for Delay.—"Replying to your letter dated 6th inst., we regret to advise you that it has not been possible to commence on the date promised you, and the only reason we can give for the delay is that the work has been delayed in progress by work on other orders which had also been delayed."

A SIGNAL-MASTER ON ACTIVE SERVICE.*

DEAR CRUICKSHANK,—

The peaceful life I tried to describe in my previous letter ended about the middle of September. During August everything was so quiet that not only was there considerable doubt as to the locality of the war, but it was even difficult to believe that a war existed at all. It was customary to visit a certain signpost, which stood on a road not far away, where one could read in large letters painted on the arm, "To the War." Whilst gazing in the direction indicated

* Passed by Press Censor.

by the arm, a distant rumbling would occasionally be heard. If the noise increased, an immediate and hasty return was made, and one was satisfied that Peace had not yet been declared.

You, of course, read Sir John French's despatches, and you therefore know all that occurred at the battle of Loos. No doubt you also read of the splendid fight made by the — Corps, where our divisions captured some of the guns that were taken. Our troops were grand; they gallantly risked and sacrificed their lives whilst upholding the traditions of the regiments to which they belonged — regiments that are famous, and always have been the flower of Britain's Army.

I opened the signal office of the — Corps Advanced Headquarters on September 21st, a marquee and two lorries forming the distribution point for telegraphs, telephones, and electric light. Difficulties immediately arose; bad earths, wires shelled to pieces, and apparatus faults, the latter being mainly due to people who would not depress the Micro. Tele. press key, and who also would not ring off. However, these troubles were well in hand before the day of the attack, September 25th. Bad weather had set in; the ground was over a foot deep in mud, and on this rested infantry, cavalry, and horses, all waiting to move forward to the attack, which was to take place after a heavy and prolonged bombardment; also something else, which you have no doubt read about. One of the chief worries on these occasions is the correct circulation of the messages. No addresses are given. They cannot be given. Only the officer concerned and the name of the unit are written. The Signal-Master must know the circulation for every division, brigade, aircraft squadron, and artillery unit with the Expeditionary Force.

During the afternoon of the 25th, another officer arrived to share the signal duties. I was not sorry; it enabled me to make up some arrears of sleep.

The Germans made a big fight for Loos. They worked their machine guns from behind tombstones in the cemetery; they sniped from the church steeple and from ruins and cellars, but they paid dearly for it. If they did not come out into the open when invited, bombs were thrown amongst them, and they lost their opportunity for ever. There are many incidents I would like to relate, but I am certain the Censor would not pass them, but "*Après la guerre.*"

.

I started with another officer at dark, and after passing through Quality Street, which, no doubt, you have read about, we reached the battle-field. The road we were on was strewn with dead horses, smashed wagons, cycles, and barbed wire, etc., and as it was being heavily shelled we decided to reach Loos through the German trenches. The route proved somewhat safer, but was very unpleasant.

The trenches were narrow, and contained many dead Germans, over whom we could not avoid walking and tumbling. However, we finally reached Loos, which was at the time being shelled, and was also smelling badly of gas. After some difficulty we found the signal office in a cellar. There we ate bully beef and drank French wine with four cavalry officers and rested for about an hour, afraid to venture into the street. The fighting line was then just outside the village. All the houses were in ruins, and the cellars contained wounded and men who were resting. We made several attempts to get away, but had to go back owing to the heavy shelling and rifle fire in the streets. The Boche was very angry that night at being ejected from the village, and as he had the range of every street in Loos he tried his hardest to do as much damage as possible. Roofs and ruined houses were falling, transport wagons were being destroyed, and ambulances were in great demand. However, after sprinting from cellar to cellar and hugging the walls, we finally got clear of the village, crossed the battle-field again, and finally reached headquarters about 2 a.m.

We returned with plenty of plunder in the shape of German telephone apparatus, on which I was asked to report later. One useful item was a galvanometer complete with cell. It could be carried easily in the pocket, and gave a noticeable deflection through 1200°. We also brought in a loud-speaking telephone, of the hand micro type, used by the artillery. The handle contains two press buttons—one for buzzer call and the other for short-circuiting the secondary coil whilst receiving. Another instrument consisted of a beautifully made piece of apparatus for detecting mining operations. This was a swinging transmitter supplied on a metal rod. When in use, the rod is driven into the ground. Any digging work causes the delicately suspended transmitter to swing, closing the transmitter circuit intermittently. The German is thorough, even in telephones.

On October 13th and 14th I was again ordered out, and this time the office was opened in a cellar. It was a small affair and fairly successful. Since October 14th I have been very quiet and contented, except for a week in England, where things did not appear to be particularly cheerful.

Winter classes are now in full swing. I am instructing thirty Artillerymen on buzzer working and lamp signalling, and also lecturing to a large class of linemen. This, with signal duties and a little riding exercise, comfortably fills in the day. My mare provides the necessary excitement to relieve the monotony. She shies at every car, lorry and ambulance met on the road. There is usually a ditch on each side of the French roads, and I can generally rely on being backed into one of them.

Sometimes we get the humorous with the tragic. During the Neuve Chapelle fight we were working telephone and Morse to one of our divisions. Unknown to the telegraphists, the telephone had been fixed in the General's private room, instead of in the Signal Office. The telegraphist, who was somewhat impatient, called up on the 'phone and told the General, who happened to answer the call, to "Attend at once on the Morse." The house in which the 'phone and Morse had been fixed had hitherto been known as "Red Barn." The troops who happened to be near enough to hear the General's remarks re-christened it "Blue Barn."

Well, there is not much worth writing about just now. The morning report continues to state that "All is quiet on our front," and the daily casualty list follows. I am well; but sometimes after a night in the open I wish I were a few years younger; but I don't want to come back until the show is over.

Kind regards to all.

Yours faithfully,

W. J. GWILLIAM, Lieut., R.E.

NOTES PREPARED BY MR. T. F. PURVES ON ONE OF THE SUBJECTS ANNOUNCED FOR BERNE CONFERENCE, 1914.

(The above Conference of the Telegraph and Telephone Engineers of European Administrations should have been held at Berne in September, 1914, but was postponed owing to the outbreak of war.)

THE CONSTITUTION OF A LOW TARIFF AREA (SUPPLEMENTARY LINES, PARTY LINES) AND THE STUDY OF THE BEST MEANS OF LAYING OUT A LARGE AREA.

1. TARIFFS must be proportioned to the cost of providing the telephone service, and a minimum tariff can therefore only be secured by the adoption of the most economical lay-out and construction of plant and the best available methods of handling telephone traffic.

2. The leading considerations in the lay-out of a large telephone area, such as those with which State Telephone Departments are generally called upon to deal, are:

(a) To make provision without waste for sufficient numbers of lines—subscribers' circuits, junction circuits, and long distant trunk circuits—at all parts of the system to avoid the necessity of reconstruction of the main elements of the plant before their economic "life" has expired.

(b) To secure a satisfactory grade of speech transmission between subscribers located at any points in the area of intercommunication.

3. The "development studies" by means of which the magnitude of future requirements is estimated have already become well established, on a more or less standardised system, among telephone administrations. The importance of such studies, and of the careful compilation therefrom of fundamental plans governing the character and location of the required plant, cannot be over-estimated. The result of calculation based on these studies is to show that in England, when underground ducts and conduits are being constructed, it is advantageous to make provision for the estimated development at the end of a period of fifteen years, and to provide underground cables of sufficient capacity to meet the estimated development of eight years. In aerial construction it is desirable to provide main pole routes capable of meeting requirements for fifteen years. In other countries, where the costs of labour and materials are not the same as in England, similar calculations would doubtless result in the establishment of somewhat different economic periods.

4. The close study recently given to the problems of speech transmission, and to the standards by which its efficiency is measured, has raised that subject to the first importance in all considerations of telephone service lay-out.

5. The grade of transmission to be maintained is the fundamental factor upon which telephone plant engineering is based. This it is which determines the amounts of capital which should be spent in providing each part of the system, and it is therefore one of the ruling elements in the settlement of questions relating to tariffs.

6. If a reduction in the general tariff can only be obtained by adopting a standard of construction which is inadequate to provide efficient commercial speech throughout the whole of the intercommunicating area, clearly it would be very short-sighted policy for any telephone administration responsible for a *National* system to agree to such a reduction. On the contrary, it would be its duty to resist demands for a lowering of the tariff and to endeavour, by intelligent and popular explanation of the conditions, to convince the public that the maintenance of a high standard of transmission efficiency, throughout the whole of the system, is the only policy truly consistent with the progressive welfare of the community.

7. The motto of the great association of "Bell" Telephone Companies in the United States of America—"Every Bell telephone is a long-distance station"—expresses a sound and statesmen-like view, namely, that the duty which a responsible telephone administration owes to the public is to make every telephone a long-distance station. It has been the basis of all the telephone operations of the British Post Office from the first.

8. Two legitimate exceptions to this general rule may be admitted :

(a) Long, multi-station "party lines" established in sparsely populated rural districts where the cost of installing systems in accordance with the general standard is prohibitive. Such rural lines, often referred to as "farmer's lines," fulfil a function of high utility in linking up outlying dwellings and farms with the nearest market towns, and with centres whence medical and other aid can be summoned in emergency, and where the rural subscribers can get into immediate touch with the telegraph system. These rural party lines must, however, be regarded as essentially *local* in their range of communication. They form no part of the system by which the urban and industrial portions of a country are telephonically united.

(b) The exigencies of international telephony may lead to the establishment of special installations, equipped with apparatus of special and expensive type, and enabling conversations to be carried on, by appointment, on the high-grade, long distance circuits without introducing the attenuating effect of junction circuits, multiple exchanges, and subscribers' loops.

9. In considering the general lines on which a national telephone system should be designed, it is necessary first to determine the limits of satisfactory commercial speech in terms of a standard of reference and thereafter to proportion the various parts of the system—subscribers' lines, junction lines, and long distance lines—in such a way that communication all over the area will be possible without exceeding these limits.

10. The standard adopted in England is 1 mile (1·61 km.) of "standard" cable. The standard consists of air-space paper-insulated conductors having a resistance of 88 ohms, a capacity of '054 microfarads, a mutual inductance of 1 milli-henry, and an insulation resistance of 200 megohms per mile (1·61 km.) of loop. Careful and long-continued trials have shown that with the standard apparatus used by the British Post Office, good conversation is possible between subscribers' stations connected with common battery exchanges by circuits not exceeding 300 ohms resistance, over a trunk line equivalent to 46 miles (74 km.) of standard cable. For successful speech over circuits of this value, it is essential that the lines and apparatus should be in first-class order, that silent conditions should obtain at both ends, and that the persons conversing should be good telephone users.

11. It is not safe to assume that these favourable conditions will always be obtainable for long distance conversations, and it has, therefore, been decided to adopt a general minimum standard of audibility equal to that obtained when two common battery subscribers, having 300 ohm loops, are conversing over a total circuit length equivalent to 35 miles (56·35 km.) of standard cable; this

figure provides a substantial reserve of audibility for localities near the extremities of the system in connection with which it may in practice have to be somewhat exceeded. The determination, within these limits, of the permissible equated value to be allotted to junction circuits between local and trunk exchanges and to trunk circuits between long distance exchanges, necessitates a careful and comprehensive study and forecast of general conditions throughout the area. Complete estimates of junction and trunk traffic in all directions have to be framed and the necessary numbers of circuits calculated and compared with the figures of anticipated local development all over the country. It is obvious that if, say, the junction circuits be made very highly efficient, it will be possible to effect economies in connection with the trunk circuits, or the subscribers' circuits, and *vice versa*. To raise the efficiency of a long trunk circuit by a few miles of standard cable involves, of course, a far heavier expenditure than would be required to effect the same improvement on a junction circuit or on a long subscriber's circuit. On the other hand, the number of trunk circuits is small compared with the numbers of junction and subscribers' circuits.

12. The practical problem is to calculate the most economical distribution of copper which will enable communication to be maintained between any two points in the area without exceeding the specified limit of attenuation, and if full and reliable forecasts are available, the subject is adaptable to fairly definite mathematical treatment. Here, again, the factors in two different areas may be quite dissimilar. The smaller the magnitude of the required long distance trunk system in comparison with the local exchange development, the greater will be the economic advantage of building trunk lines of very high transmission efficiency.

13. After careful study of these considerations, the British Post Office has decided to establish what are termed "zone centres" at nine selected points throughout the country, and to connect these centres together by main trunk lines of the highest obtainable order of transmission efficiency. Secondary switching centres, known as "controlling centres," will be connected with the zone centres, and, to a certain extent, with each other. Ordinary trunk exchanges—which serve the local exchanges in their vicinity by means of junction circuits—will obtain long distance communication through their controlling centres, which will, when necessary, utilise the zone centres.

14. It has, so far, been determined that the equated value of the combined junction and trunk lines by means of which any local exchange can reach its zone centre shall not exceed 10 miles (16.10 km.) of standard cable, and that in any case the equated length shall not exceed that which would be obtained were the line

provided by means of conductors in a standard cable; that is, the distance of a local exchange from its zone centre governs, to some extent, the equated length allowed. It has also been determined that the resistance of a common battery subscribers' loop shall not exceed 300 ohms, except at exchanges situated in towns which are zone centres (where a maximum loop resistance of 450 ohms for subscribers' circuits will be allowed). From this it follows that the equated value of the lines used to connect one zone centre with another should not exceed 15 miles (24.15 km.) of standard cable, in order that the total equivalent of 35 miles (56.35 km.) between local exchanges may not be exceeded.

15. In practice, it is not in all cases possible to keep within these limits. Some local exchanges in the more remote parts of the kingdom are 200 miles distant from a zone centre; and where, in such cases, there are two intermediate switching points between the local exchange and the zone centre, the average efficiency of the line must not be worse than 0.045 miles of standard cable per mile of route if the limit of 35 miles of standard cable is not to be exceeded. To obtain this average efficiency of 0.045 per route mile requires the erection of very heavy copper lines, and it has not been possible to justify the expense in some of the sparsely populated remote districts. Communication between very widely separated localities cannot, therefore, in some cases, be given without approaching the commercial limit of 46 miles of standard cable.

16. In order that money may not be spent in providing for an unnecessarily high grade of transmission between exchanges which are comparatively close together, it is necessary that a certain equated length of circuit should be chosen as a *minimum* within which it is not permissible to work when calculating the gauge of wire to be used for a given purpose. It is considered that the audibility obtained, with a 300 ohm subscribers' loop, over a trunk line equivalent to 25 miles (40.25 km.) of standard cable is sufficiently good for all purposes, and steps are therefore taken to ensure that circuits, provided for short distance traffic only, shall not be of heavier gauge than is required to reach that figure.

17. Junction circuits providing direct communication between local exchanges in the same area are of such gauge that their equivalent shall not exceed that of 20 miles (32.2 km.) of standard cable.

18. For subscribers' circuits, underground conductors weighing 10 lb. per mile (0.62 mm. diameter), are largely employed; and a still lighter type of conductor, weighing 6½ lb. per mile (0.5 mm. diameter), has recently been introduced and will be used in all cases where the specified maximum resistance will not thereby be exceeded. It will be noted that even with these very light conductors it is possible

to serve subscribers situated at a distance of more than a mile (1·61 km.) from the exchange in towns which are not zone centres, and at a distance of about 1·75 miles (2·12 km.) in zone centres. The physical exigencies of underground cable manufacture prevent the use of wires lighter than the minimum quoted above. For open line construction wires of 40 lb. bronze (1·3 mm. diameter) are used, and those are capable of satisfactorily serving subscribers up to a distance of 3 miles (4·82 km.) from the exchange—nearly 5 miles (8 km.) in zone centres. Here again it is not desirable, for physical reasons, to employ a lighter type of conductor.

19. It is clearly of no real advantage to the clients of any telephone administration that very long distance conversations can be carried on with great ease between *some* of their number. A public service is judged by the facilities it places at the disposal of *all*. It is only by taking the fullest advantage of all economies in construction, at points where such are possible without transgressing the limits of transmission efficiency allowed by the fundamental design of the telephone system as a whole, that the best economic results can be achieved, and that the service can be offered to the public at a minimum tariff.

PARTY LINES.

20. Among special devices adopted for the purpose of providing cheap telephone service, the equipment of party lines has uniformly held a leading place. They have their legitimate uses; they also have their abuses, and it is not quite clear which of these two aspects has been most in evidence throughout their history. After much study of the subject, the British Post Office is convinced that party lines have little or no place in the telephone system of a *commercial* community. As "residence" telephones at reduced tariffs, it may be contended that they fulfil a certain useful function in attracting a lower stratum of the population to the telephone and assisting in the development of "the telephone habit." But in this respect—the encouragement of the "small" man to use the telephone—the universal measured service is itself the most powerful popularising influence that has yet been devised. For obvious reasons, party lines accord badly with the principle of measured service. They are essentially a product of "flat-rate" conditions, and it is noteworthy that they have attained a fair degree of development only in administrations where service has been given on a flat-rate basis. The lowering of the cost of modern line construction has, to a large extent, destroyed their *raison d'être* by reducing the savings which can be offset against the increased cost of equipping and maintaining party line apparatus as compared with that of direct lines.

21. In order to provide a party line service which will be tolerated by any appreciable number of subscribers, it is essential that the principle of selective calling from the exchange be employed. This practically limits the number of subscribers who can be served by one circuit to a maximum of four, and it represents the utmost extent to which any administration should go in building up the complexity of apparatus in the effort to disguise the disabilities of party lines as compared with direct line service. Electrical and mechanical elaborations devised to provide secrecy of communication, by "locking out" all other parties while one is engaged in conversation, increase maintenance costs so seriously that they can only be looked upon as misdirected efforts.

22. These remarks apply to party lines considered as part of a standard telephone system serving the town and village communities of a country. As already indicated, the establishment of rural party line services is an important branch of the enterprise of a national telephone administration, but such systems must be looked upon as essentially self-contained, and as standing apart from inter-connecting telephone network of the country by reason of the low standard of transmission efficiency which is necessarily associated with circuits of this class.

HEADQUARTERS NOTES.

C.B. EXCHANGE EQUIPMENTS.

THE following contracts for new exchange equipment have been placed:

Manchester Trunk Exchange	Additional supervisor's desk.
Norwich	Additional equipment for 240 subscribers' lines.

Installation of the following contracts has been commenced:

Dublin	Junction equipment.
Finchley	Additional equipment for 700 subscribers' lines.
Greenock	Additional equipment for 400 subscribers' lines.
Manchester Central	New exchange equipment for 7500 subscribers' lines.
Perth	New exchange equipment for 1000 subscribers' lines.
Salisbury	Additional equipment for 160 subscribers' lines.

Sutton	Additional equipment for 800 subscribers' lines.
Ryde	New exchange equipment for 400 subscribers' lines.

The following equipment contracts have been completed :

Darlaston	New exchange equipment for 108 subscribers' lines.
Dover	New exchange equipment for 700 subscribers' lines.
Devonport	New exchange equipment for 760 subscribers' lines.
Woking	New exchange equipment for 600 subscribers' lines.
Lee Green	Additional equipment for 200 subscribers' lines.
Manchester City	Additional equipment for 2140 subscribers' lines.
North (London)	Additional equipment for 1000 subscribers' lines.
Willesden	Additional equipment for 540 subscribers' lines.
Brixton	Additional equipment for 1500 subscribers' lines.
Birmingham (East)	Additional equipment for 60 subscribers' lines.
Edgbaston	Additional equipment for 880 subscribers' lines.
London Trunk	Chief supervisor's desk.

LONDON DISTRICT NOTES.

NEW TELEPHONE LINES.—During the thirteen weeks ended October 26th, 1915, 2211 exchange lines, 2338 internal extensions and 289 external extensions were provided. In the same period 3001 exchange lines, 1451 internal extensions and 179 external extensions were recovered, making a net decrease of 790 exchange lines and a net increase of 887 internal extensions and 110 external extensions.

EXTERNAL CONSTRUCTION.—For the three months October 31st, 1915, the net increase of telephone exchange wire mileage of the London Engineering District was 13,587 miles, the increase under the head of underground being 15,104 miles, whilst open (bare wire) and open (aerial cable) decreased by 424 and 1093 miles respectively.

Telephone trunk wire mileage is the same as the July quarter, but telegraphs decreased by 38 miles.

Pole line increased by . . . 2 miles

Pipe „ „ . . . 30 „

The aggregate mileages in the district at the end of October, 1915, under the various services were as follows:

LINE MILEAGE.—Pole line (bare wire), 2481 miles; pipe line, 3477 miles.

SINGLE WIRE MILEAGE.—Telegraphs, 21,431; telephone exchange, 992,859; Telephone trunks, 30,732. Inclusive of spare wires, but exclusive of Post Office wires on railways maintained by railway companies. The total length of cables is now 7080 miles.

Staff withdrawn for Military Service from the District up to November 20th, 1915.

Ranks.	Total withdrawn.	Percentage of total staff.
Engineers . . .	2 . . .	4·08
Inspectors . . .	32 . . .	12·45
Workmen . . .	1250 } . . .	33·92
Boys and Youths . . .	318 }	
Clerical . . .	209 . . .	46·34
Total . . .	1811 . . .	33·10

Military Decorations, etc.

Name.	Regiment.	Distinction.
Tupper, F. M.	Royal Engineers (Sapper)	Medal of St. George, 4th Class (Russian).
Hopkins, E.	Royal Engineers (Lance-Corp.)	Mentioned in Commander- in-Chief's Despatch.

CENTRAL TELEGRAPH OFFICE SECTION—*Street Tubes*.—In connection with a scheme to extend certain long-distance tubes to the principal telegraph gallery in the Central Telegraph Office a 6 in. riser main has been erected between the ground and third floors. This main is necessary to provide vacuum-power for “up” working between out offices and what is usually known as the “centre,” where most of the provincial telegrams are dealt with. In consequence of the difficult route, it was necessary to bend and have threads specially cut on this heavy main, but the work has been successfully accomplished.

Baudot.—A type-writer keyboard has been experimentally tried on a Glasgow circuit, but did not prove very successful. If typists

are to displace Baudot operators, it would appear to be necessary for a slip to be perforated and for the slip to be passed through a transmitter actuated by the cadence signals. Here is a real chance for an inventor to earn a reward or, at least, fame!

Morse.—A “Yetman” typewriter keyboard has been fitted experimentally on the Chichester circuit. This keyboard, which conforms to the standard arrangement from a typist’s point of view, translates the usual depressions into Morse signals on a sounder circuit, with the staccato effect usually heard when a Wheatstone transmitter runs at key-speed.

AUGUSTUS EDEN.

(BORN NOVEMBER 28TH, 1842; DIED JULY 8TH, 1915.)

A FEW days ago—or was it many years?—we began to hear at Headquarters about the great ability of a test clerk at E.H. Soon rumour said that “Preece” intended to bring him to London; and a little later still (January 1st, 1884), Eden came to “Room 90.” He was the advance guard of selected men who, as years went on, were to strengthen the tiny nucleus that then constituted the “Electrician’s” Staff. These recruits dribbled in: William Brown, “of Newcastle,” had already joined in 1883; H. Hartnell (the student who would start to learn Japanese or Russian as an after-supper recreation, and would rather tell you what the Germans said in German about G.P. than explain in English what he himself knew, which was more to the point) came in 1884; then (1887) came F. Tremain, idealist, altruist, and optimist, then, as now, overflowing with energy; followed by T. F. Purves (1893), whose coming, I used to assure him, spoilt a good draughtsman by taking so much of the work out of my hands; and W. M. Evans, now an R.E. Captain, ordered to France within a week of being gazetted. The present Engineer-in-Chief did not arrive until 1898, taking a senior position in recognition of his services as exponent and pioneer of telegraphic technical instruction in the Post Office. In the meantime (1895) the “trunk transfer” had at last swept away the policy of staff-starvation that had cramped all Preece’s efforts, and we entered on the era of the *great* Headquarters Staff! How strange it seems to look back on that short long time ago! and the “boy Stubbs” now called upon for notes on Eden’s life because he is the “father” of the Headquarters staff! It is fitting that Eden should be signalised as primarily and essentially a Headquarters officer. If it is reasonable to call him an “advance guard” of the later *régime*, it is probably quite as correct to recognise him as the rearguard of those

who conquered and held for the Empire a foremost position in the telegraph engineering world. For, indeed, it was *they*, not *we*, who have done this.

Eden was an observer, an experimentalist. Perhaps he would have gained distinction as an administrative and executive officer if he had gravitated in that direction earlier in life. But, constitutionally, he was not built for such a *rôle*. The virtues of such a character raised antagonism in his mind. To him their practice would have been a vice. He figuratively always spelt TACT in capital letters, and defined it to mean hollowness, chicanery, meanness, and bluff.



Yet withal, when he allowed himself to do himself justice, those who knew him sympathetically well understood that beneath his seeming brusqueness there lay a great stratum of gentle-heartedness.

I think that, as an engineer, he deserves a distinguished niche as an experimenter. He had in a marked degree an *instinct* in research. He arrived at correct conclusions without the preliminary argument—sometimes without the ability to frame the argument—by a sort of insight into the nature of things—a grasp of their essentials. He would bring forward an interesting and valuable new observation by, say, showing a few figures and saying, “It comes right every time! It’s one of those things that no fellow can understand”! This, or something like it, was the genesis of his very ingenious “battery-testing instrument.” This, or its equivalent, led to his elaborate “morning testing system.” Both devices (I cannot say, “alas”!)

have been swept away by the whirligig of time or the logic of facts. Both represented a great simplification of the previous system in their respective spheres, but the introduction of accumulators left us no room for elaborate battery testing, and the enormous development of main lines and main line traffic rendered it impossible to utilise beneficially such a mass of information as the morning test scheme provided.

The original "battery testing board" had been made up from some obsolete resistance coils mounted on a board with a short-circuit piece, and Eden was very delighted when I insisted that the rheostat and lever switch form was the only reasonable thing when I designed his new instrument.

It was always a matter of regret to me that Eden could not devote the necessary time to writing technical instructions on duplex, Wheatstone system, and repeaters. I could (and to a certain extent did) provide the mechanical portion, but I felt sure that he could have produced, in unexcellable form, an illuminating exposition of how to keep the circuits at the highest pitch of efficiency.

He would, I fear, be rather "at sea" in our present Research Section; but so would Newton and many another giant if they revisited the fields that were peculiarly their own sphere of operations and discovery!

In 1902 he refused to take charge of a District, believing that representations which had been made that Staff Engineers should in equity be graded as equal to Superintending Engineers would lead to his receiving a recognition to which he felt entitled, without the need to abandon work which was his delight and to take up duties essentially unlikely to provoke his enthusiasm. This reform was not to come until Major O'Meara's re-organisation scheme of 1911, after Eden had retired. In 1904 Eden felt obliged to accept the offer of taking charge of the Northern District. I cannot ascertain that he ever tried to settle seriously to the new life, or to enter into the local electrical engineering interests of Newcastle, as his predecessor, A. W. Heaviside, had done. His restlessness found expression in his transfer to Edinburgh in 1905; but that was no cure. The northern capital had lost most of the attractions of the 1880's, when his comparatively humble position as an official of the Post Office was overshadowed by his social qualities and military ability as an indefatigable Volunteer Artillery officer. His sometime chums who still lived there had wealth and social position which the older man of high official rank could not overlook, even though the others were prepared to do so; and I fancy that "Ichabod" (the glory is departed) was writ large over Eden's later thoughts of the fairy city of his earlier life. That word

induces me to say that it is by no means out of place to "quote Scripture" in connection with Eden. His knowledge of Scripture, if not deep, was peculiar, and his quotations ready and apt; never irreverent, but never pretending to the quality of devotion. "Is thy servant a dog that he should do this thing?" I remember in one of his numerous and amusing letters. "Unto which of us? Unto thee, O captain," his response to an inquiry as to whether a compliment was meant for himself or for me.

On two occasions at least he was sent officially to the Continent. To Berlin once (if not twice) in connection with Hughes' duplex working, I think, and his assistance was very highly appreciated. I fancy he had no love for the Germans; his own military experience led him to notice adversely the brutal and oppressive discipline in trifles to which the officer class was addicted, and he found that this same cast-iron discipline permeated all official life. For instance, accredited as he was to the German Post Office at their request by the British Post Office, and treated with the greatest consideration by the officials, his permit did not include admission to the telephone exchange—*therefore* he could not be permitted to see it! Perhaps this was right; it was certainly in marked contrast with our own treatment of foreign visitors. He also visited Holland in connection with repeater matters, and was in touch also with the Belgian telegraph administration.

On November 29th, 1907, he retired from the Post Office service, but continued to take full interest in technical matters.

Of his private life but little can be said. His first marriage was not a success, and to him home-life was something distinct from happiness. I was his groomsman at his second wedding, but only once visited his house. I know, however, from those who knew him well during that later period that he was well contented with his home.

To his widow is offered a respectful expression of sympathy, which these notes may perhaps help to convey.

His was a remarkably interesting personality. Possessed of a fine presence and good military bearing, he was an excellent conversationalist, able to listen as well as to talk, and with a sufficient working knowledge of many subjects to listen intelligently and to bring a fresh point of view into a discussion. He was always considerate and helpful; encouraging younger and less experienced men by his obvious sympathy with their efforts and his readiness to assist.

Mr. C. Crompton (who did not go to Edinburgh until after Eden left), in an interesting letter, says:

"Soon after war broke out, Mr. Eden, in spite of his years, offered his services to the Headquarters Staff of the Scottish command for

training young officers ; and his activities in that direction continued until the early part of this year, when a severe attack of influenza laid him up. His strong will power and strong physique pulled him through the illness ; but a weakness of the heart was left, and although, under medical advice, he sought the softer climate of Southport in order to escape the rigours of springtime here, he unfortunately failed to improve, and was brought back to Edinburgh at the end of June a complete invalid. He died on July 8th at his own home at Joppa, near Edinburgh.

“ The funeral was attended by many members of the Engineering Staff from Edinburgh and Glasgow, by Messrs. Campbell and Machugh—his two predecessors in the East Scotland District—and many representatives from the railway companies and other undertakings also paid the last tribute to an ex-official who had held the esteem of all.”

It has been a privilege to be allowed to attempt by these few notes to express appreciation of one of whom I have many pleasant memories—and who was my friend.

A. J. S.

RETIREMENT OF MR. F. TREMAIN.

ON August 1st, 1915, Mr. F. Tremain retired from the position of Superintending Engineer of the South-Western District after completing forty-five years in the service of the State. He commenced his official career at Plymouth in 1870, and was transferred to the Engineering Department in 1887. One of his earliest important achievements was the conception of the idea of abandoning the weight drive for the Hughes printing telegraphs in favour of the electric drive, and the working out of the practical details which subsequently led to the universal adoption of that system of control. The versatility of Mr. Tremain had yet to be illustrated, and his transfer to the office of the Engineer-in-Chief gave him opportunities for studying new and varied problems mainly concerned with subterranean and submarine cables for telegraph and telephone working. Mr. Tremain took an active part in the laying of the first paper-core cables, and was largely responsible for the carrying out of experiments in the balancing of conductors to eliminate disturbance between the pairs of the first London-Birmingham cable. It is interesting to note *en passant* that the scheme which was then introduced has quite recently been brought to a high state of perfection, principally as the result of the availability of sensitive capacity measuring apparatus. The remarkable benefits to be derived from the system are exemplified in the cables recently laid between

London-Birmingham, London-Liverpool, Leeds-Hull, etc., which lend themselves so admirably to superposed working.

Mr. Tremain devoted much thought to the question of securing a type of underground conductor for telegraph purposes which would be free from inductive disturbance, and carried out experiments on the earliest form of cables consisting of a number of single lead-covered conductors and known as the Oxford type. A measure of success was achieved by this type of telegraph cable, but the difficulty of handling the numerous failures due to the breakage and perforation of the small lead sheaths and the high costs led to its abandon-



MR. TREMAIN : A CHARACTERISTIC ATTITUDE.

ment and the introduction of the copper-screened conductor about the year 1898. A thirty mile length of this type of cable, containing seven screened wires, was laid in the Nantwich Warrington district, and Mr. Tremain was responsible for the testing and laying of the cable and for the final experiments which determined the efficacy of the screening, and resulted in the adoption of this method of eliminating interference.

To Mr. Tremain was allotted the task of following up the ideas of Oliver Heaviside, Sylvanus Thompson, and subsequently Prof. Pupin, which had for their object the improvement in the transmission efficiency of underground telephone loops. Experiments were commenced on a length of paper-core cable laid between Birmingham and Wolverhampton, the cable being cut and intercepted at suitable

intervals by cable connection boxes accommodated in test pillars. Mr. Tremain designed the first loading coils and used them on the circuits of this cable. Only those who have had experience in the difficulties of air core loading coils can fully appreciate the patience, perseverance, and skill which Mr. Tremain showed in devising means for eliminating the excessive degree of cross-talk which was introduced on the circuits after the installation of the coils, and of ultimately arriving at a design of coil which has since been shown by the use of modern high frequency testing apparatus to be almost perfect in its arrangement and proportions. A number of cables were loaded with the pattern of coil ultimately developed, and as long ago as 1903 it was found possible to converse satisfactorily over a length of 200 miles of a 100 lb. underground conductors so treated.

To realise the magnitude of this achievement it must be borne in mind that standard cables and apparatus for measuring the characteristics of circuits at telephone frequencies had not then been introduced, and it speaks volumes for Mr. Tremain's grasp of the problem that the results were so remarkably satisfactory.

Mr. Tremain's methods of conducting elaborate and telling experiments were a revelation to those privileged to witness them, and his enthusiasm was only exceeded by the energy with which he pursued new ideas when once satisfied that they had any merit. In the earlier days of loading, the "Coils, inductance $\frac{4}{4}$," were looked upon with suspicion, almost distrust, by both workmen and engineers called upon to see to their installation, and this in spite of the fact that Mr. Tremain never lost an opportunity of endeavouring to enlighten all with whom he came in contact as to the precise construction and function of the "box of mysteries."

In 1903, Mr. Tremain was called upon to form the construction section of the Engineer-in-Chief's office, and he at once inaugurated the occasion by making extensive plans for replacing all the gutta-percha underground cables by air-space paper-core cable.

Mr. Tremain invented the quadruple pair cable, which has been used so extensively in the Department's service and has been found so eminently satisfactory. The adoption of the scheme and the introduction of the differential lay of the conductors forming the cable resulted in the means being afforded for superposing on cable circuits. In 1903 Mr. Tremain showed the feasibility of superposing on a quadruple pair cable and actually worked seven circuits on eight wires forming a portion of the loaded quadruple pair cable between Liverpool and St. Helens.

Mr. Tremain's optimism was truly remarkable, and was well illustrated on the occasion of the laying of the Bolina Road cable in

London. At the time it was manufactured it was the largest cable on record, and was designed to give the very small wire-to-wire capacity of '045 mfs. per mile. When the cable was placed on the drums at the contractor's works the inspector reported that it had flattened and was elliptical in shape with a major axis of about $4\frac{3}{4}$ in. The cable in its cylindrical form was $3\frac{3}{4}$ in. in diameter and was to be drawn into a 4 in. pipe. The only individual who remained undisturbed by the prospect was he who carried all the responsibility for the design, and Mr. Tremain never doubted but that the cable would resume its original formation when the critical time arrived to commence drawing-in operations. The rollers and other devices designed by those who did not share his optimistic views were never used, and the cable found its resting place without any coercive measures being necessary.

In surveying Mr. Tremain's activities in his official life alone one finds so many important and interesting innovations in which he was concerned that only the recollection of the Editor's blue pencil causes one to pause. Perhaps, however, I may crave his indulgence to refer, in conclusion, to Mr. Tremain's design of a low capacity submarine cable. The cable was made up of two copper conductors, which were flattened for the greater portion of their length to form half round conductors, and the flattened portions were divided up into sections by protuberances formed at intervals. The conductors were insulated with paper, and placed with the flat faces opposing to give an air space between them in each flattened section. The whole was insulated with paper, rubber, gutta-percha, and finished off in the manner of the usual submarine armoured cable. Unfortunately, the exudation of moisture from the gutta-percha and the hygroscopic characteristic of the insulating paper rendered the cable liable to failure after prolonged immersion, and these practical difficulties led to the abandonment of what might otherwise have been a great advance in the manufacture of submarine telephone cables.

Fortunately for many of those associated with him, Mr. Tremain had that facility for stimulating a real interest in the problems in hand, and his store of knowledge was an open book to all who cared to profit by it; the results of his investigations and researches were secrets to none who wished to know them.

In his retirement those who know him can never picture him living in inactivity, and we wish him many years of happiness, during which he may continue to probe the mysteries of science which have ever fascinated him.

H. P. B.

THE LATE MR. JAMES MARTIN,

Croydon.

THE sympathy of engineering officers throughout the Service has been aroused by the untimely death of Mr. James Martin, which occurred on November 1st.

Although for some time past Mr. Martin had not been in the enjoyment of his usual good health, there was no cause for alarm, as he was able to perform his duties up to the last, and his sudden end,



due to heart failure, was all the more regrettable to those who were intimately associated with him.

Entering the Post Office in November, 1872, he was appointed Telegraphist at Newcastle-on-Tyne, where he remained for a period of thirteen years. As an expert operator of all forms of apparatus then in use, he was regularly selected for duty at race meetings and other special events in the North country. The substitution of telephones for the extensive system of A.B.C. working, which had grown up on Tyneside, developed rapidly, and, up to the time of leaving Newcastle, Mr. Martin was closely associated with the traffic control of the "Telephone Room." In August, 1885, he was appointed Relay Clerk at Haverfordwest, and during the following six years played an active rôle in the improvement of apparatus designed for cross-channel signalling. At this period the technical experts of old Room 90, G.P.O., were greatly exercised as to the respective merits

of the various systems of duplex working for submarine cables, and valuable assistance was rendered by Mr. Martin in carrying out, from time to time, experiments which finally ended in the adoption of the pure Bridge method. Leaving Haverfordwest in December, 1891, he was appointed to Sheffield as Second Class Engineer. In those days clerical assistance was not recognised for engineers, and as the construction programme in the Section was, for some years, of considerable magnitude, he spent a strenuous life and had little opportunity for social recreation. At Sheffield he was promoted to the rank of First Class Engineer. Mr. Martin's next promotion was to a Second Class Staff Engineership in August, 1905, in which capacity he was largely engaged in extending the field of Wheatstone and undulator systems of working, in connection with which he has repeatedly subscribed articles to this JOURNAL. In March, 1911, he was appointed to the South Wales District as Assistant Superintending Engineer, and latterly was transferred to the South-Eastern District at Croydon. His service extended over a period of forty-three years, although he was only fifty-nine years of age.

Of a quiet, retiring disposition, Mr. Martin possessed the faculty of making friends wherever he went, and was held in high esteem, not only by his colleagues, but by a large circle of friends in private life.

J. R. M. E.

INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS.

COUNCIL NOTES.

A SPECIAL meeting of the Council was held in London on November 17th to deal with matters arising from the abnormal conditions prevailing due to the war.

CLERICAL ASSISTANTS.—In connection with the proposal to admit clerical assistants as associates of the Institution, the Secretary reported that the additional expenditure which would be incurred could not be sanctioned at the present juncture, and for the present the privileges of associateship could not be extended to the officers mentioned.

WINTER PROGRAMMES.—Most of the Centres had been able to arrange meetings, but in consequence of the depletion of the staff, and in order to reduce expense as far as possible, an average of three meetings had been decided upon. Two or three centres, which are specially affected by the war, have been compelled to suspend operations.

POST OFFICE ELECTRICAL ENGINEERS' JOURNAL.—The Council considered a report submitted by the Board of Editors with reference to the difficulties experienced in connection with the publication, but after full discussion it was decided to continue as at present. The possible withdrawal of some members of the Board for military service and other unavoidable conditions arising out of the war might render a reconsideration of the position of the JOURNAL advisable, but until circumstances arose which would necessitate suspension every effort will be made to avoid such a contingency.

MEMBERSHIP.—The Secretary reported that fourteen new Colonial members had been admitted, all of whom belonged to the Engineering Staff of the New Zealand Government.

The Council decided to recommend to the members that there should be no election for representatives of the various classes on the Council for next year, and members will be approached with a view to obtaining their consent to the present members of Council carrying on the work for a further period of twelve months.

T. SMERDON,
Secretary.

LOCAL CENTRE NOTES.

LONDON CENTRE.

As the members are already aware the Committee decided, with the approval of the Council, to curtail the programme for the present session. It was not considered desirable to hold the usual number of meetings in view of the demands made upon the *personnel* of the Department by the war.

The first meeting of the session took place therefore on November 8th, when the President delivered an address on "Telephones." This being the first occasion upon which the President has met the members since the honour of knighthood was conferred upon him by H.M. the King, Sir William received a very cordial reception, and acknowledged the congratulations of the meeting on behalf of himself and Lady Slingo.

In addition to the chairman of the Council, Mr. A. J. Stubbs, the Controller of the Stores Department, Mr. G. Morgan, and the Controller of the London Telephone Service, Mr. G. F. Preston, were present. Sir A. F. King, Colonel Ogilvie, and Mr. J. Newlands, all of whom had intimated their intention of attending the meeting, found themselves unable to be present on account of pressing engagements.

Sir William's address was of a most interesting character, tracing

as it did the development of the telephone system in England, and outlining the probable policy of the Department with regard to the future. The members will receive with much pleasure the announcement that the address is to be printed, and will be circulated immediately.

During the course of his remarks Sir William found time to pay a very generous tribute to the work performed by the Engineering Department in connection with the war, and stated that should the history of these times ever come to be written it would be found that the Department had responded nobly to the demands made upon it. The meeting terminated with a hearty vote of thanks to the President.

The Committee have much pleasure in stating that one of their number—Mr. J. G. Hines—has received a commission in the Royal Engineers. They wish him God-speed and a safe return.

W. G. O.

SOUTH WALES CENTRE.

The opening meeting of the 1915-16 session was held at the South Wales Institute of Electrical Engineers, Park Place, Cardiff, on October 11th, 1915, when Mr. A. S. Renshaw (of the Engineer-in-Chief's Office), who was on an official visit to Cardiff, gave an interesting paper on "The Ethics of Supervision."

Mr. W. H. Lane, of the Cardiff Technical Section, gave a paper on the 8th inst., at the above-mentioned Institute, on "Trunk and Junction Working, with the use of Unit Auxiliary Apparatus." The lecture, which introduced some lantern-slides, was a most interesting one, and open to a great deal of discussion.

NORTHERN CENTRE.

Owing to the large number of members away on active service it was decided, after taking a plebiscite of the district, that meetings would not be arranged during the 1915-16 winter session.

NORTH-EASTERN CENTRE.

The first meeting of the session was held at the Y.M.C.A., Leeds, on November 9th.

Mr. T. B. Johnson, in opening the session, gave a brief *résumé* of the position of the Institution at this critical time, mentioning the fact that only three meetings would be held this session, and also remarking on the enlistment of many of the members of the local branch.

Mr. W. H. Thornburn then read a paper on "Vandyke Plans and other Records," pointing out clearly the Department's require-

nents and the use made of the records. A lengthy discussion followed, in which engineering officers took the chief part; the opinions expressed being about equally divided as regards the value of the records and the view that much unnecessary labour was involved.

LIST OF OFFICERS IN THE ENGINEERING DEPARTMENT HOLDING COMMISSIONS IN THE ARMY OR NAVY (THIRD LIST).

Name.	Office or District.	Military Rank.	Corps.
Perrin, E. S.	E. in C.O.	2nd Lieut.	Royal Flying Corps, Wireless Sect.
Close, C. N.	Testing Branch	"	3/1st Wessex Sig. Coy. Royal Engineers.
Mantz, J. F.	London	Capt.	Army Ordnance Corps.
Gerke, J. J.	"	2nd Lieut.	58th Divl. Sig. Coy., Royal Engineers.
Ost, H. J.	"	"	9th Battn. Somerset Light Infantry.
Cooper, W. F.	"	"	16th Battn. K.R.R.
McClarence, F.	"	"	Royal Engineers.
Neate, E. P.	"	"	"
Coxon, J.	Met. Power	"	"
Buchanan, J.	North-Western	"	"
Starkey, H. Y.	South Mid.	"	2/4th Battn. Norfolk Regt.
Bradfield, R.	South-Western	"	Dorset Fortress Coy., Royal Engineers (T.).
Gauld, R.	"	"	3/1st Highland Divl. Sig. Coy., Royal Eng.
McKichan, J. J.	South-Eastern	Sub-Lieut.	R.N.V.R.
Winn, R. W.	"	"	Ditto
De Wardt, J. C.	"	2nd Lieut.	Kent Fortress Coy., Royal Engineers.
Readhead, A. O. J.	"	"	"
Haslam, J. G.	"	Lieut. & Qmr.	Royal Engineers.
Roberts, E. S.	E. in C.O.	2nd Lieut.	"
Coates, G. A.	South-Eastern	"	"
Hines, J. G.	London	"	"
Kimber, J. W.	"	"	London Army Troops Signal Coy., R.E (T.)

Captain Mantz has been on active service since October 23rd, 1914. We regret that his name had been omitted inadvertently from the previous lists.

The total list of officers withdrawn for active service from the Engineering Department up till November 30th is as follows :

Engineering officers	47
Chief inspectors, etc.	27
Senior „ „	27
Inspectors	79
Clerical officers	774
Skilled workmen (established)	1536
„ „ (unestablished, labourers, youths, etc.)	5848
Other grades	355

Total 8693

In addition to the above there are 103 Royal Engineers withdrawn from Ireland.

BOOK REVIEWS.

‘Alternating Current Work,’ by W. Perrin Maycock, M.I.E.E. (Whittaker & Co. Price 6s. net.)

This book is a very excellent attempt at dealing with the mathematical subject of alternating currents non-mathematically. Indeed, as the author says, “the calculus has not been allowed to show its fearsome face within these pages, and the very little trigonometry that has been used is briefly explained.” While this, of course, limits the scope and utility of the work for such as are more or less conversant with these branches of mathematics, nevertheless the book will no doubt prove very popular among the large circle of students of the subject who have not the time nor possibly the inclination to take up the study of mathematics seriously. The subject is treated on broad lines, and a feature of the book is the wide use made of mechanical and hydraulic analogies.

The first chapter introduces the reader to electrical engineering generally and the scope of the book in particular, the importance of alternating current working being specially dwelt upon.

Chapter II, headed “General Principles,” explains the terms to be met with, and gives a series of very interesting mechanical analogies, illustrating the effects of resistance, inductance, and capacity in a circuit. The expression for inductive reactance is proved, but the author merely states the formula for capacity reactance, with a note that it must be taken for granted. The usual methods for the calculation of the impedance of circuits are fully given.

“Power, polyphase currents,” etc., are dealt with in the third chapter, interesting hydraulic analogies to “wattless” currents, and

the flow of current in a three-phase circuit being included. This chapter also contains a clear and well-illustrated description of a wattmeter, and a discussion of the methods of measuring power in polyphase circuits.

In the chapter on alternations there is a good description of the different types to be met with, their general construction and windings and methods of synchronising, including a description of the "synchronoscope."

Chapter V opens with the subject of choking coils, and gives as a practical example a complete description of a "dimming switch" for electric light. The different methods of construction and transformers, the types met with, their advantages and disadvantages, and methods of testing are fully discussed.

The final chapter treats of alternating current motors, including synchronous motors, induction motors, and single-phase commutator motors. A simple explanation of the working of each type is given, together with a discussion of their characteristics and spheres of usefulness. The method of constructing the "circle diagram" for induction motors is stated, and the different methods of starting explained. A very useful collection of City and Guilds and A.M.I.E.E. questions is provided at the end of each chapter, answers being given for all numerical questions. An index of formulæ and a *resumé* of the vector diagrams contained in the book are somewhat novel features.

The book is well written, well illustrated, and well printed, and as a preliminary introduction to the study of alternating currents is thought to be unequalled.

MILITARY HONOURS.

THE Board of Editors has great pleasure in publishing the following further list of honours awarded to members of the Engineering Department on active service :

Sergeant Faithfull and Private Binks had already been awarded the Distinguished Conduct Medal, and Sergeant Scaife was mentioned in despatches. Lance-Corporal Halsall was JOURNAL representative in Manchester until called to the colours, and his distinction is particularly gratifying.

Capt A. Evans, R.E., Signal Service (Assistant Engineer, Peterborough). Mentioned in despatches.

Sergt. A. E. Faithfull, R.E., Signal Company (Skilled Workman, Class II, South-Eastern District). Awarded the Cross of the Order of St. George, 4th Class (Russian).

Sergt. T. J. Scaife, R.E. (Skilled Workman, Class II). Awarded the Medal of St. George, 2nd Class (Russian).

Sap. F. M. Tupper, R.E., Signal Service (Unestablished Skilled Workman, London District). Awarded the Medal of St. George, 4th Class (Russian).

Pte. R. Binks, King's Royal Rifles (Labourer, Northern District). Awarded the Medal of St. George, 3rd Class (Russian). The name of Pte. Binks appeared in our Roll of Honour list of last issue—killed in action.

Lce.-Cpl. T. G. Halsall, R.E., Signal Service (Third Class Clerk, South Lancs. District). Mentioned in despatches.

Sap. George Frier, R.E., Signal Service (Skilled Workman, Class II, Scotland, E.) Awarded the Distinguished Conduct Medal.

Sergt. S. B. Andrews, Signal Coy., R.N. Div. (Skilled Workman, Class I, Eastern District). Mentioned in despatches.

Sergt. E. Pratt, Royal Warwicks (Unestablished Skilled Workman, Birmingham). Awarded the Distinguished Conduct Medal.

" K " COMPANY, R.E.

Lce.-Cpl. J. C. Williams. Awarded the Medal of St. George, 3rd Class (Russian).

Sap. A. E. Messenger. Awarded the Cross of the Order of St. George, 4th Class (Russian).

TWO EDINBURGH SECTION D.C.Ms.

IN our last issue attention was directed to the fact that two members of the Lincoln Section staff had gained the Distinguished Conduct Medal. Edinburgh Section now claims a similar distinction in the persons of Private W. McFarlane of the 2nd Royal Scots, and a "braw, braw lad" from Galashiels, Sapper George Frier, R.E.'s Signal Service.

Private McFarlane's name appeared in our October list of honours as having received the D.C.M., and in the special P.O. Circular of November 27th, appeared the following account of the deed that brought him the award:

For conspicuous gallantry as a stretcher-bearer, notably on the night of February 28th, 1915. When a company was heavily shelled on this bright night, he, with three others, went to the rescue of a wounded man, and although one of the stretcher-bearers was killed and Private McFarlane himself was wounded, they succeeded in bringing the man in.



PTE. W. MCFARLANE, 2ND ROYAL SCOTS. D.C. MEDAL ON LEFT. KING'S SOUTH AFRICAN IN CENTRE. QUEEN'S SOUTH AFRICAN ON RIGHT.



SAPPER GEORGE FRIER, R.E., SIGNAL SERVICE.

The photograph was taken in Edinburgh last month ; McFarlane has been discharged from the Army and is now a fitter in the Section.

Sapper Frier volunteered to connect up a wire between headquarters and the trenches in face of severe fire and great danger. Along with a sergeant of the Argyle and Sutherland Highlanders he successfully carried out the work and established communication between the points.

ROLL OF HONOUR.

The Board of Editors sincerely regrets to record the deaths on active service of the undermentioned members of the Engineering Department. Fifth List. All the names are from the Army.

Name.	Rank.	District.
J. Angell	Unest. Skilled Workman	S.W.
W. H. Archer	Labourer	Eastern.
R. Ashton	"	N.W.
R. Atkinson	"	N.
W. Atkinson	Unest. Skilled Workman	S. Lancs.
F. Banks	"	London
C. J. Barratt	Youth	London
L. Barratt	"	S. Lancs.
E. Berwick	Labourer	S. Mid.
J. Brooker	"	"
J. W. Brown	"	N.
J. W. Burnett	Assistant Clerk	London
J. W. Clarke	Youth	N. Mid.
J. W. Cliffe	"	Eastern
W. J. Collins	Labourer	S.W.
E. C. Crowe	"	Eastern
F. Crummett	Unest. Skilled Workman	"
F. Dank	Boy	London
T. F. Elliott	Unest. Skilled Workman	S. Mid.
J. L. H. Firman	Labourer	Eastern
E. Hackett	"	S. Mid.
R. G. Harradine	"	S. Mid.
P. G. Heffron	"	S. Lancs.
J. W. Hogg	Unest. Skilled Workman	"
E. Jeffery	Labourer	S.E.
W. A. Kemp	"	S. Mid.
G. G. Kethel	Junior Electrical Assistant	Scot. W.
W. J. Leonard	Unest. Skilled Workman	S.E.
E. F. Levick	"	London

STAFF CHANGES.

STAFF

Name.	Rank.	District.
D. S. Linklater . . .	Unest. Skilled Workman	Scot. E.
J. N. G. Lynch . . .	Youth	S. Mid.
G. A. Mankelow . . .	Labourer	S.E.
W. Martin . . .	"	S.W.
G. J. Medford . . .	Skilled Workman, Cl. II	S. Lancs.
D. Mitchell . . .	Unest. Skilled Workman	Scot. E.
A. Nineham . . .	Youth	S. Mid.
M. Nolan . . .	"	London
H. J. Rabbitts . . .	"	S.E.
T. J. Redfern . . .	Labourer	N.E.
F. Roberts . . .	Clerical Assistant	"
W. G. Robinson . . .	Labourer	N. Wa.
J. Rome . . .	"	Eastern
J. Reeves . . .	"	S. Wa.
S. G. Selley . . .	Clerical Assistant	S.E.
E. R. Shepherd . . .	Circuitman	S. Wa.
G. W. Southam . . .	Unest. Skilled Workman	N.E.
W. F. Spiller . . .	"	S. Mid.
J. Summer . . .	"	"
A. Taylor . . .	"	N. Wa.
D. Thomas . . .	Labourer	S. Wa.
E. Ticehurst . . .	Unest. Skilled Workman	S.E.
G. W. Valerius . . .	"	London
A. E. Wiles . . .	Skilled Workman, Cl. II.	N.E.
H. D. Wilson . . .	Unest. Skilled Workman	S. Mid.
H. Woodley . . .	Labourer	Eastern
W. E. Wright . . .	"	London
W. E. Young . . .	Youth	S. Mid.

STAFF CHANGES.

POST OFFICE ENGINEERING DEPARTMENT.

PROMOTION.

Name.	From.	To.	Date.
Smith, D.	Sub.-Engr., Scot. E. Dist.	Chief Inspector, Scot. E. Dist.	29 : 11 : 15

STAFF**STAFF CHANGES.****TRANSFERS.**

Name.	Rank.	Transferred from.	To.	Date.
Hannaford, F. S.	Asst. Engr.	N. Wales	S.E.	22 : 11 : 15
Burton S. G.	Clerk, 3rd Cl.	Scot. W.	S.E.	20 : 8 : 15
Frost, M. P.	"	London	Ireland	5 : 12 : 15

RETIREMENTS.

Name.	Rank.	District.	Date.
Bryant, S. G.	Asst. Engineer	S. Wales	Superantd. 18 : 11 : 15
Bates, T.	Clerk, 2nd Class	Northern	" 12 : 9 : 15
Richardson, R. W.	Clerk, 3rd Class	"	" 15 : 10 : 15

DEATHS.

Name.	Rank.	District.	Date.
Martin, J.	Asst. Suptg. Engr.	S.E.	6 : 11 : 15
Jeffery, W.	Clerk, 3rd Class	London	28 : 11 : 15

BOARD OF EDITORS.

T. F. PURVES, M.I.E.E., Chairman. J. W. ATKINSON, A.M.I.E.E.
 A. W. MARTIN, A.M.I.E.E. A. O. GIBBON, A.M.I.E.E.
 Major A. C. BOOTH, R.E. W. T. HARRIS.
 W. CRICKSHANK, A.M.I.E.E., Managing Editor.

COMMUNICATIONS.

All Remittances and Communications should be addressed to the **MANAGING EDITOR**, P.O.E.E. JOURNAL, Engineer-in-Chief's Office, G.P.O. West, London, E.C.

A few copies of Part 1, Vol. 1, and Part 1, vol. 7, of the JOURNAL are required by the Board. Full price will be paid for copies in good condition, or another part can be sent in exchange. The JOURNALS may be sent to the Managing Editor direct, or through the local agents.

Binding covers and copies of the Contents Index for Vol. 7 are available, and may be obtained from the local agents for 1s. and 2d. respectively. The same charges will be made for the covers and indices for Vol. 8, which will be ready by the end of January. Subscribers can have their copies bound, with index included, at a cost of 1s. 9d., by sending the JOURNALS to the local agents. Orders should indicate whether the original binding covers, or the later pattern, are required.

A supply of the first instalment of the Station List of Engineering Officers eligible for membership of the Institution, issued with the April, 1914, number of the JOURNAL, and including all officers down to Assistant Engineers, is in stock, and copies can be obtained on demand, price 3d. each.

Index

THE POST OFFICE ELECTRICAL ENGINEERS' JOURNAL

Vol 8
1915/1916



VOL. 8
PART I



APRIL
1915

ESTABLISHED 1879.

THE LONDON ELECTRIC WIRE COMPANY AND SMITHS, LTD.

Telegrams: "Electric, London."

Telephone: No. 3105 London Wall.

Playhouse Yard, Golden Lane, London, E.C.

MANUFACTURERS OF

**Every Description of Cables &
Wires for Electrical Purposes.**

Cotton-Covered & Braided Wires, Strips & Cables.

Silk-Covered Wires for Electrical Instruments.

Enamel Insulated Wires.

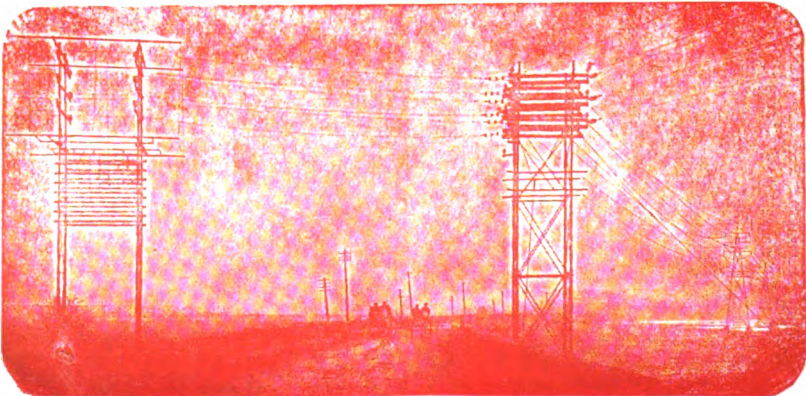
Multiple Cables for Telephones, &c.

Flexible Cords of all descriptions.

Dynamo Brushes.

"Eureka," "Platinoid," ^{AND} _{OTHER} High Resistance Wires.

TUBULAR STEEL TRANSMISSION TOWERS

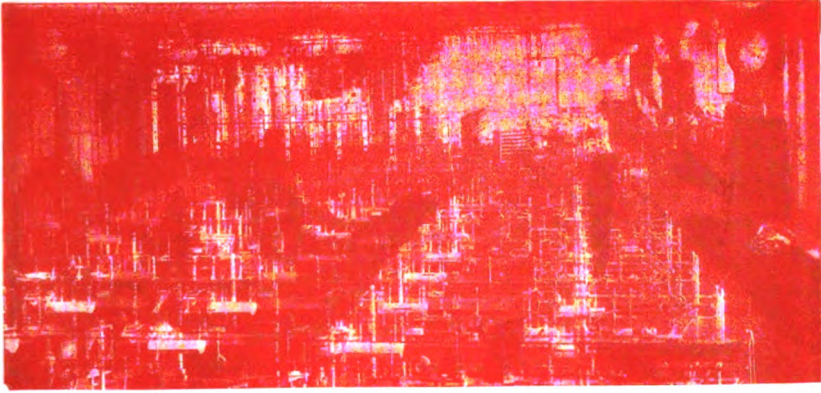


TRAMWAY, TELEGRAPH & TELEPHONE POLES

High-Pressure Steam Pipes for Generator Stations

CATALOGUES ON APPLICATION

GLASGOW **STEWARTS AND LLOYDS, LTD.** BIRMINGHAM



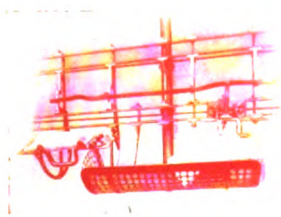
A most ingenious Labor-saving device.

THE illustration shows a portion of the Lamson Pick-up Installation at Birmingham Post Office. This ingenious apparatus handles thousands of telegrams daily, carrying them from Check Table to any of 151 different points on Operators' Tables, and *vice versa*.

The Lamson Automatic Pick-Up

was exhibited on the British Post Office Stand at the Ghent Exhibition in 1913. It was inspected by engineers and business men from all parts of the world and awarded the Gold Medal.

The Pick-up is not limited to telegrams, but will carry and deliver all kinds of business papers, packages, and small parts, within and between buildings.



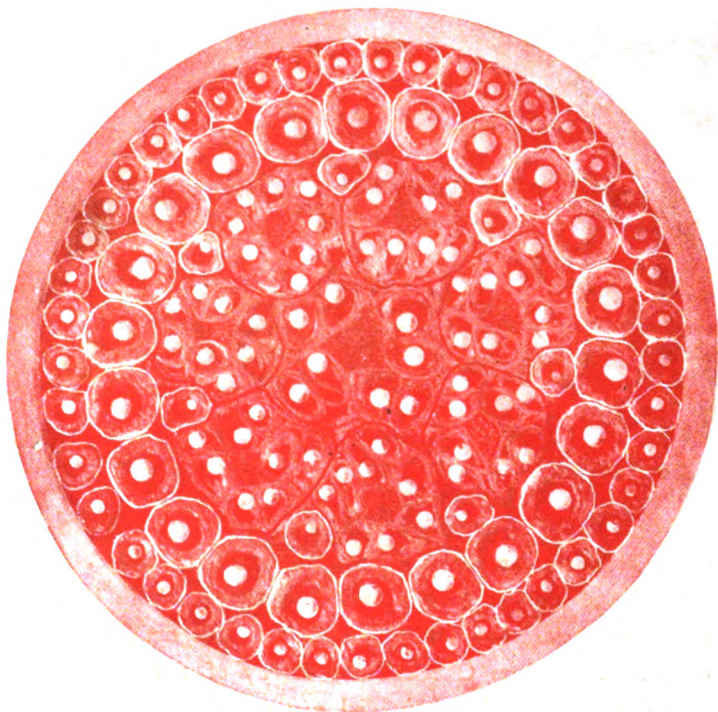
Pick-up Car delivering a message.

*May we send you particulars of this System?
Every Postal & Telegraph Engineer should
be acquainted with its capabilities. Enclose
your card and mention this Journal.*

Lamson Company,
20 Cheapside, London, E.C.

Contractors to P.O., Admiralty, War Office, etc.

LAMSON PNEUMATIC TUBE CO., LD.



DRY CORE TELEPHONE CABLES.

Electrical Plant of every description for
Power, Lighting, & Wireless Installations.

JOHNSON AND PHILLIPS ^{LD}
CHARLTON, LONDON. S.E.

ESTABLISHED 1875.

INDEX

THE POST OFFICE ELECTRICAL ENGINEERS' JOURNAL



**VOL. 8
PART 2**



**JULY
1915**

ESTABLISHED 1879.

THE LONDON ELECTRIC WIRE COMPANY AND SMITHS, LTD.

Telegrams: "Electric, London."

Telephone: No. 3105 London Wall.

Playhouse Yard, Golden Lane, London, E.C.

MANUFACTURERS OF
Every Description of Cables &
Wires for Electrical Purposes.

Cotton-Covered & Braided Wires, Strips & Cables.
Silk-Covered Wires for Electrical Instruments.

Enamel Insulated Wires.

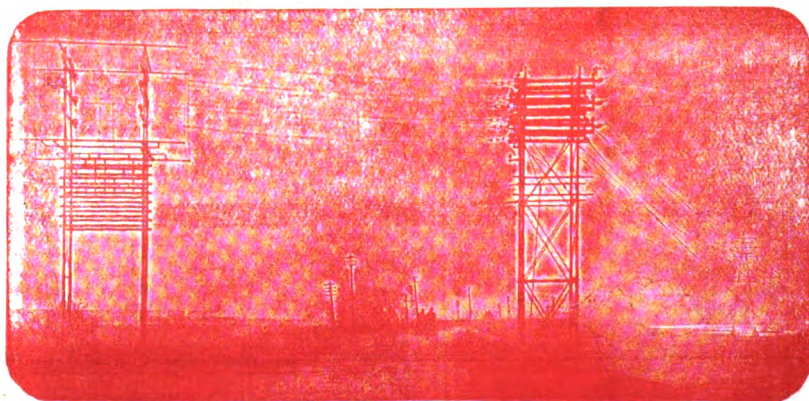
Multiple Cables for Telephones, &c.

Flexible Cords of all descriptions.

Dynamo Brushes.

"Eureka," "Platinoid," AND OTHER High Resistance Wires.

TUBULAR STEEL TRANSMISSION TOWERS



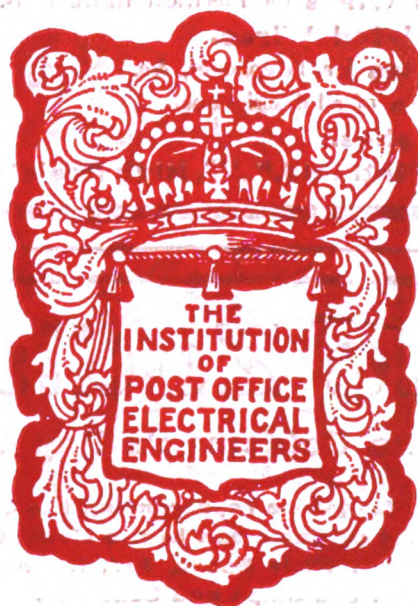
TRAMWAY, TELEGRAPH & TELEPHONE POLES

High-Pressure Steam Pipes for Generator Stations

CATALOGUES ON APPLICATION

GLASGOW **STEWARTS AND LLOYDS, LTD.** BIRMINGHAM

THE POST OFFICE ELECTRICAL ENGINEERS' JOURNAL



VOL. 9
PART 3

OCT:
1915



ESTABLISHED 1879.

THE LONDON ELECTRIC WIRE COMPANY AND SMITHS, LTD.

Telegrams: "Electric, London."

Telephone: No. 3105 London Wall.

Playhouse Yard, Golden Lane, London, E.C.

MANUFACTURERS OF

**Every Description of Cables &
Wires for Electrical Purposes.**

Cotton-Covered & Braided Wires, Strips & Cables.

Silk-Covered Wires for Electrical Instruments.

Enamel Insulated Wires.

Multiple Cables for Telephones, &c.

Flexible Cords of all descriptions.

Dynamo Brushes.

"Eureka," "Platinoid," ^{AND} _{OTHER} High Resistance Wires.

"The Zodiac,"

The Cableman's Paper.

**A Monthly Magazine representing the Social Life
of the World of Cablemen in the Home Countries
and Overseas: their Sport, Art, Literature, and
the Gossip of the Ships and Stations.**

*Illustrated with beautifully reproduced Photographs and many
charming Drawings.*

SIXPENCE MONTHLY.

YEARLY SUBSCRIPTION, Post Free, to any part of the World, **6s.**

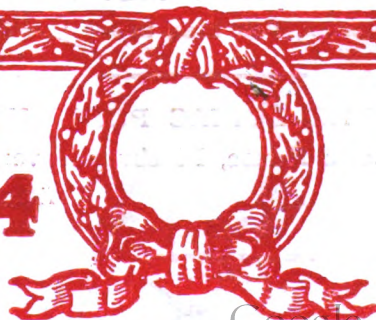
Published by THE ZODIAC PUBLISHING CO., Ltd.,
Electra House, Finsbury Pavement,
LONDON, E.C.

THE POST OFFICE ELECTRICAL ENGINEERS' JOURNAL



VOL. 9
PART 4

JAN.
1910



ESTABLISHED 1879.

THE LONDON ELECTRIC WIRE COMPANY AND SMITHS, LTD.

Telegrams: "Electric, London."

Telephone: No. 3105 London Wall.

Playhouse Yard, Golden Lane, London, E.C.

MANUFACTURERS OF
Every Description of Cables &
Wires for Electrical Purposes.

Cotton-Covered & Braided Wires, Strips & Cables.

Silk-Covered Wires for Electrical Instruments.

Enamel Insulated Wires.

Multiple Cables for Telephones, &c.

Flexible Cords of all descriptions.

Dynamo Brushes.

"Eureka," "Platinoid," ^{AND} _{OTHER} **High Resistance Wires.**

"The Zodiac,"

The Cableman's Paper.

**A Monthly Magazine representing the Social Life
of the World of Cablemen in the Home Countries
and Overseas: their Sport, Art, Literature, and
the Gossip of the Ships and Stations.**

*Illustrated with beautifully reproduced Photographs and many
charming Drawings.*

SIXPENCE MONTHLY.

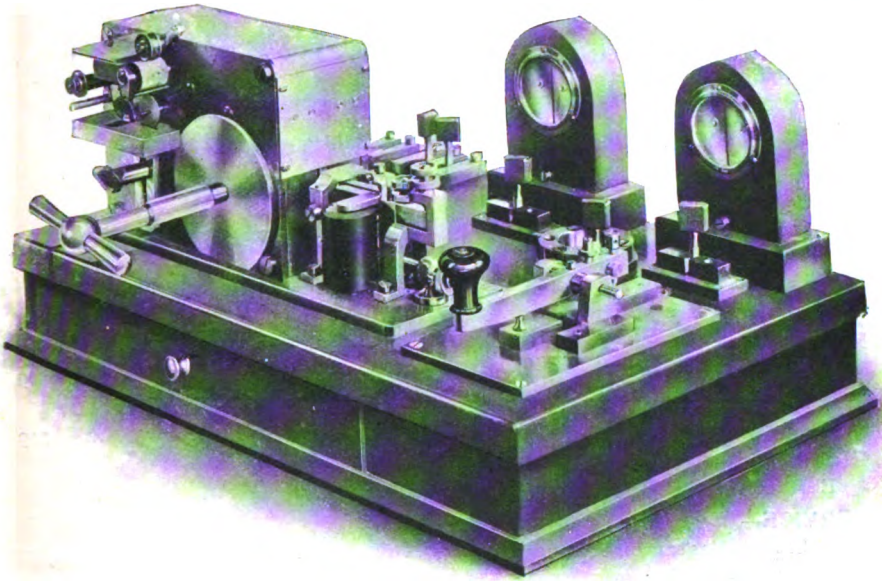
YEARLY SUBSCRIPTION, Post Free, to any part of the World, **6s.**

Published by THE ZODIAC PUBLISHING CO., Ltd.,
Electra House, Finsbury Pavement,
LONDON, E.C.



A.T.M.

Inker - Sounders.



R 205 Intermediate Non-Polarized Inker-Sounder.

— ALSO —

R 202	Terminal Non-Polarized Inker-Sounder.	
R 203	„ Polarized	„
R 208	Intermediate Polarized	„
R 206	Translating Non-Polarized	„
R 217	„ Polarized	„

*With these instruments signals are recorded on
:: the tape, and can also be read by ear. ::*

Automatic Telephone Manufacturing Co., Ltd.

Head Office and Works :

Milton Road, Edge Lane, Liverpool.

London Office :

Lennox House, Norfolk Street, Strand.

The Post Office Electrical Engineers' Journal.

A QUARTERLY JOURNAL

CONTENTS FOR JANUARY, 1916.

COPYRIGHT.—The entire contents of this Journal are covered by general copyright, and special permission is necessary for reprinting long extracts, but Editors are welcome to use not more than one third of any article provided credit is given at the beginning or end thus: "From the 'Post Office Electrical Engineers' Journal.'"

TELEPHONES—	PAGE
TRUNK AND JUNCTION CIRCUIT DEVELOPMENT—I. H. JENKINS, A.M.I.E.E., AND H. W. WHITE	281
BREAKDOWN—	
THE COLLAPSE OF IRON POLES AT BRIGHTON	302
POWER—	
OVERHEAD ELECTRIC LIGHT AND POWER CIRCUITS—	309
MACHINERY—	
LETTER-STAMPING MACHINES—A. B. EASON, M.A.	319
EDITORIAL—	
EDITORIAL NOTES AND COMMENTS	326
SERVICE—	
A SIGNAL-MASTER ON ACTIVE SERVICE	333
CONFERENCE—	
NOTES PREPARED BY MR. T. F. PURVES ON ONE OF THE SUBJECTS ANNOUNCED FOR BERNÉ CONFERENCE, 1914	336
HEADQUARTERS NOTES	342
LONDON DISTRICT NOTES	343
AUGUSTUS EDEN	345
RETIREMENT OF MR. F. TREMAIN	349
THE LATE MR. JAMES MARTIN	353
COUNCIL NOTES	354
LOCAL CENTRE NOTES	355
LIST OF OFFICERS IN THE ENGINEERING DEPARTMENT HOLDING COMMISSIONS IN THE ARMY OR NAVY (THIRD LIST)	357
BOOK REVIEWS	358
MILITARY HONOURS	359
TWO EDINBURGH SECTION D.C.Ms.	360
ROLL OF HONOUR	362
STAFF CHANGES	363

PUBLISHERS:

H. ALABASTER, GATEHOUSE & Co., 4, LUDGATE HILL, E.C.

Price 1/- net, post free, 1/3.

Annual Subscription, postage
inclusive, 5/-, payable in advance.

Editorial Communications see page 253.

BRITISH MADE

TELEPHONES

Many of the telephones and much of the telephonic apparatus in use in Great Britain and Colonies is GERMAN MADE.

SUPPORT ENGLISH MADE

Telephones and Apparatus by sending your enquiries to

THE BRITISH L.M. ERICSSON

MFG. CO., LTD.,

5, Chancery Lane, London, W.C.

(Telephone : Holborn 5340),

who have their own fully equipped Factory at

BEESTON, NOTTS,

and guarantee the same workmanship as supplied to the POST OFFICE, WAR OFFICE, ADMIRALTY, & all the leading railways. They further guarantee that

NO GERMAN PARTS

are used in any of their products, and they have

**NO GERMAN DIRECTORS. NO GERMAN STAFF.
NO GERMAN FACTORY.**

== *ESTIMATES GIVEN FOR ALL KINDS OF* ==

**BRITISH MADE STAMPINGS, TURNED AND
MACHINED PARTS.**

NO ADVANCE IN PRICES.

SIEMENS TELEPHONES



Standard British Post Office
Automatic Wall Telephone.



Standard British Post Office
Automatic Table Telephone.

We manufacture and erect Public Telephone Exchange Systems for both **Manual & Automatic Working** in all parts of the World.

We also manufacture and supply every class of telephone apparatus for private installations.

Price Lists and full particulars from

SIEMENS BROTHERS & CO., LIMITED.

Telegrams:
"Siemens Woolwich."

WOOLWICH, LONDON, S.E.

Telephone:
City 6400 (7 lines).

Home Branches:

BIRMINGHAM.—Central House,
New Street.
BRISTOL.—20, Bridge Street.
CARDIFF.—89, St. Mary Street.

GLASGOW.—66, Waterloo Street.
MANCHESTER.—196, Deansgate.
NEWCASTLE-ON-TYNE.—64-68,
Collingwood Buildings.

SHEFFIELD.—22, High Street.
SOUTHAMPTON.—46, High Street.

Indian and Colonial Branches:

CALCUTTA.—Clive Buildings, Clive
Street.
BOMBAY.—Rampart Row.
MADRAS.—4, McLean Street.
SINGAPORE.—1, 2, 6 and 9, Win-
chester House.

JOHANNESBURG.—Siemens' Bldg.
CAPETOWN.—7 and 11, Waterkant
Street.
SYDNEY.—42, Bridge Street.
MELBOURNE.—Dominion Cham-
bers, 59-61, William Street.

WELLINGTON (N.Z.).—A. & T. Burt,
Ltd., Courtenay Place.
DUNEDIN (N.Z.).—A. & T. Burt,
Ltd., Stuart Street.
AUCKLAND (N.Z.).—A. & T. Burt,
Ltd., Customs Street, West.

SIEMENS DRY CELLS

BRITISH
POST OFFICE
STANDARD
SIZES.



$1\frac{1}{2} \times 1\frac{1}{2} \times 4\frac{1}{2}$ in. high.
Weight: 10 oz.



$2\frac{1}{16} \times 1\frac{3}{8} \times 3\frac{3}{8}$ in. high.
Weight: 1 lb.



$2 \times 2 \times 5\frac{1}{2}$ in. high
Weight: 1 lb. 6 oz.



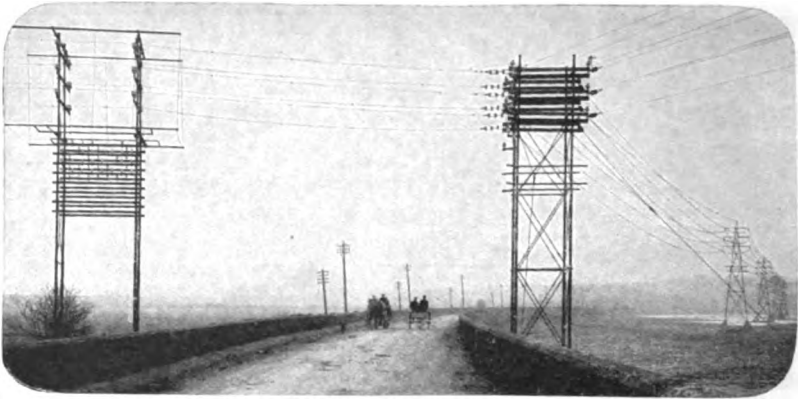
$2\frac{1}{16}$ in. diam. $\times$ $7\frac{1}{2}$ in. high.
Weight: 2 lb. 6 oz.



$4\frac{7}{8} \times 4\frac{7}{8} \times 8\frac{1}{2}$ in. high. Weight: 9 lb. 10 oz.

SIEMENS BROTHERS & CO., LTD., WOOLWICH.

TUBULAR STEEL TRANSMISSION TOWERS



TRAMWAY, TELEGRAPH & TELEPHONE POLES

High-Pressure Steam Pipes for Generator Stations

CATALOGUES ON APPLICATION

GLASGOW **STEWARTS AND LLOYDS, LTD.** BIRMINGHAM

“St. Martin’s-le-Grand”

The Post Office Quarterly Magazine.

**Circulates throughout the Post Offices of
the United Kingdom, the British Colonies,
and Foreign Countries.**

3/- PER ANNUM. SINGLE COPIES 9d.

N.B.—Any profit remaining after due provision has been made for carrying on the Magazine is devoted to the furtherance of benevolent and philanthropic objects connected with the Post Office. An Annual Balance Sheet is published in the Magazine.

Hon. Treasurer.—ARTHUR G. FERARD, Esq.

Hon. Editor.—EDWARD BENNETT, Esq.

Assistant Editor.—R. W. HATSWELL, Esq.

All Communications to be addressed—

c/o Messrs. W. P. GRIFFITH & SONS, Ltd., Old Bailey, London, E.C.

ADVERTISEMENTS.

For Terms apply to Messrs. Pratt & Co., 9, Essex Street, Strand, London.

FREDERICK SMITH & CO.,

Incorporated in
The London Electric Wire Co. & Smiths, Ltd.,
ANACONDA WORKS, SALFORD, MANCHESTER.

HARD DRAWN H.C. COPPER LINE WIRE.

Special Tinned H.C. Copper Wire.

COPPER TAPES AND BINDERS FOR LINE WIRE.

COPPER TROLLEY WIRE

SPECIAL NON-FOULING SECTIONS.

SILICIUM BRONZE WIRE

"C" Quality for Telephone Lines, &c.

ALUMINIUM WIRE & STRIP FOR ALL ELECTRICAL PURPOSES.

— THE —

"Electrical Review."

— ESTABLISHED 1872. —

The Oldest and yet the most Up-to-date
:: Electrical Newspaper in the World. ::

**Electric Traction, Power, Lighting, etc.
Reliable, Unbiassed, Original, Invaluable.**

HAS BY FAR THE LARGEST CIRCULATION OF ANY
ELECTRICAL INDUSTRIAL PAPER IN GREAT BRITAIN.

UNRIVALLED as an ADVERTISING MEDIUM.

— Scale of Charges for Trade Advertisements on application. —
Special Prepaid Rate of Advertisements of Situations Vacant or Wanted.

Published Friday 9 a.m.,

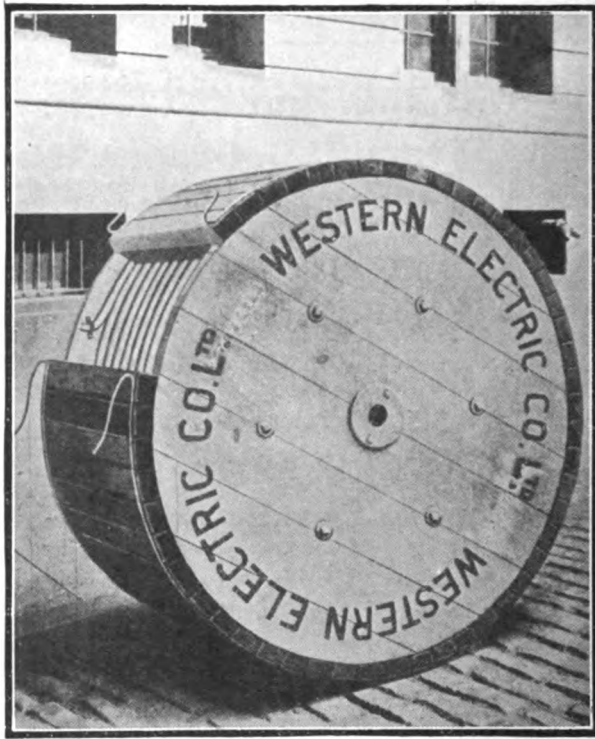
4½^{d.} Post Free.

**Advertisements received up
to 9.30 a.m. on Thursday.**

London: H. ALABASTER, GATEHOUSE & CO., 4, Ludgate Hill, E.C.

On Every Highway and By-way

these drums of



Western Electric **CABLE**

bear silent witness to the universal satisfaction
resulting from its use.

BEST

for overhead lines and indispensable for
underground construction.

Western Electric Company Limited.

WORKS: N. WOOLWICH, E.

ECONOMISE.



SAVE MONEY BY INSTALLING

A

HART

BATTERY.

LOW INITIAL COST.

HIGH WORKING EFFICIENCY.

LOW MAINTENANCE COSTS.

FULL PARTICULARS FROM

HART ACCUMULATOR CO., LTD.

STRATFORD, LONDON.

Telephones :
EAST 1306-1307.

Telegrams :
"HARTMOSEL, BOCHURCH, LONDON."

INDEX TO ADVERTISERS.

	PAGE
Alabaster, H., Gatehouse & Co.	iv and ix
Automatic Telephone Mfg. Co., Ltd.	iii
British L.M. Ericsson Mfg. Co., Ltd.	v
Hart Accumulator Co., Ltd.	xi
Henley's, W. T., Telegraph Works Co., Ltd.	xiii
Johnson & Phillips, Ltd.	xvi
London Electric Wire Co. & Smiths, Ltd.	ii
Peel-Conner Telephone Works, Ltd.	xiv
S. Rentell & Co., Ltd.	xv
'Saint Martin's-le-Grand'	viii
Siemens Bros. & Co., Ltd.	vi and vii
Smith, Frederick, & Co.	ix
Stewarts & Lloyds, Ltd.	viii
Western Electric Co., Ltd.	x
Wireless Press, Ltd.	xii
'Zodiac'	ii

NOW READY.

The Year-Book of Wireless Telegraphy & Telephony 1915

This important work of Reference contains:

- A unique collection of all the **Laws and Regulations** relating to Wireless Telegraphy throughout the World.
- A complete Alphabetical List of Land and Ship Stations with their call letters.
- A Glossary of Technical Terms printed in Five Languages.
- Map of the Wireless Stations of the World (revised March, 1915), giving location of over 700 Stations.
- International Time Signal Regulations.

Together with a vast amount of exclusive information upon technical subjects.

900 Pages.

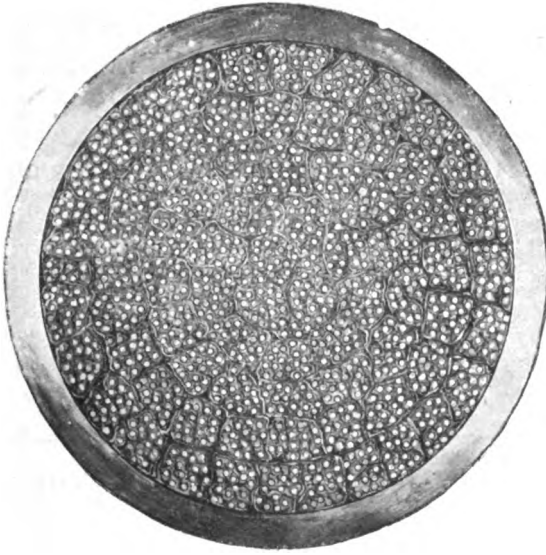
PRICE **3/6** NET.

Illustrated.

Postage: United Kingdom, 6d. extra; Abroad, 1s. 4d.

THE WIRELESS PRESS, LTD., MARCONI HOUSE, STRAND, W.C.

HENLEY'S TELEPHONE CABLES



Full-size sectional illustration of Lead-covered 606 pair 10 lb. Conductor Dry Core, Multiple Twin . . Type . .

You are able to place every reliance upon Henley's Telephone Cables because the knowledge and skill used in their construction has been evolved out of many years' experience in the manufacture of all types. The largest buyers in the World—Governments, Corporations, and Companies—use Henley's Telephone Cables.

W. T. Henley's Telegraph Works Co., Ltd.
Blomfield Street,
LONDON,
E.C.

STANDARD TECHNICAL WORKS

Of Direct Interest to all P.O. Electrical Engineers.

AUTOMATIC TELEPHONY. A clear description of the Strowger Automatic Telephone System as adopted by the G.P.O. By S. TURNER, Engineer-in-Chief's Office. 32 pp., illustrated. 7d. net, post free.

TELEPHONE TROUBLES, AND HOW TO FIND THEM. On both the Magneto and C.B. Systems. Sixteenth Edition. Thousands in use. 7d. net, post free.

HANDBOOK FOR WIRELESS & INLAND TELEGRAPH OPERATORS. By CHARLES WARD. A useful and practical work. Price (post free) 1s. 1d. net.

THE HANDY ELECTRICAL DICTIONARY. By W. L. WEBER, M.E. Contains definitions of over 4800 distinct words, terms and phrases. 1s. 1d. cloth, and 1s. 8d. leather, post free.

THE TELEGRAPHISTS' AND TELEPHONISTS' NOTE BOOK. Third Edition. Handy pocket size, $5\frac{1}{2} \times 3\frac{1}{4}$ inches, with squared pages for Memoranda, Calculations, etc. Highly spoken of by leading P.O. officials. Price 1s. 6d. net, or 1s. 7d. post free.

QUESTIONS AND SOLUTIONS IN MAGNETISM AND ELECTRICITY. By W. J. WHITE, M.I.E.E. Containing solutions to all questions in magnetism and electricity set by the Board of Education and the C. and G. Inst., for the years 1907-1913. Crown 8vo. Fully illustrated. Price 1s. 8d. post free.

THE HUGHES AND BAUDOT TELEGRAPHS. By ARTHUR CROTCH. Invaluable to students, as a knowledge of both systems is now demanded by the examiners. Cloth, 8vo. 1s. 6d. net, 1s. 8d. post free.

TECHNICAL TELEGRAPHY AND TELEPHONY. By ROBERTS and BURROWS. Fifth Edition. Containing "Hints to Students," together with an exhaustive selection of questions and model answers in all grades of the C. and G. Telegraphy and Telephony exams. Completely revised and brought up to date. 1912-13 examinations included. Post free, 2s. 2d. net.

THE TELEGRAPHISTS' GUIDE. By BELL and WILSON. Absolutely the best and most up-to-date work of its kind on the market. For class teachers and students alike it is invaluable, and the repeated calls for fresh editions prove its merit. Sixteenth thousand. 2s. net, or 2s. 3d. post free.

CALCULATIONS IN TELEGRAPHY AND TELEPHONY (Ordinary and Honours Grades). By H. P. FEW, Silver Medallist, etc. Contains full solutions to the numerical problems set by the C. and G. Inst. in the Ordinary and Honours Grade of Telegraphy and Telephony from 1900 to 1910. 2s. net, 2s. 3d. post free.

NOTES ON TELEGRAPHY. By G. MOGG. A simple exposition of the rudiments of technical telegraphy and telephony. Specially designed to meet the requirements of the C. and G. Ordinary Examinations. 2s. 6d. net, or 2s. 9d. post free.

QUESTIONS AND SOLUTIONS IN TELEGRAPHY AND TELEPHONY. By H. P. FEW. Includes model solutions to the C. and G. exams. 1904-1911, as well as to several typical questions set at the Post Office Departmental exams. for Overseerships. Third edition. Cloth. 178 pages, 144 illustrations. 2s. 6d. net, or 2s. 9d. post free.

GUIDE TO THE PRACTICAL ELEMENTS OF ELECTRICAL TESTING. By J. WARREN. A useful work, clearly expressed and well illustrated. 3s. 6d. post free.

PRACTICAL TELEPHONY. By JAS. BELL, A.I.E.E., and S. WILSON, A.M.I.E.E. A simple and practical handbook suitable for students, artisans, etc. Copiously illustrated. Latest edition. Twelfth thousand. 3s. 6d. net, 3s. 9d. post free.

MANUAL OF WIRELESS TELEGRAPHY. By Comdr. S. S. ROBISON, U.S.N. The standard text-book for Marconi students. Recommended by the editor of the P.O.E.E. Journal, The Electrical Review, and by all the leading teachers. Latest edition. Cloth, 8vo. 241 pp., illustrated. 8s. net, 8s. 4d. post free.

PRACTICAL TELEGRAPHY. By H. W. JENVEY, M.I.E.E. Electrical Engineer to the Postal Department, Victoria. A standard text-book specially suitable for Colonial telegraphists. Fourth edition, revised and enlarged. Cloth, 8vo. 444 pp. and 83 illustrations. 10s. 6d. net, 10s. 9d. post free.

TELEPHONY. By SAM'L G. McMEEN and KEMPSTER B. MILLER, M.E. The latest and best book published on the Theory and Practice of All Phases of Telephone Work. 960 pp., 700 illustrations. 17s. net.

STANDARD TELEPHONE CONSTRUCTION METHODS. By FRANK B. HALL. This book contains 250 full-page drawings of standard materials and methods of construction; 250 pages of specifications and tables. No detail from sub-station to main distributing frame omitted. Price 17s. net, post free.

AMERICAN TELEPHONE PRACTICE. By KEMPSTER B. MILLER. Fourth Edition, entirely rewritten and greatly extended. 904 pp., 6 x 10, 643 illustrations. 17s. net.

Sent Post Free at Prices stated by

S. RENTELL & CO., Ltd., 36, Malden Lane, Strand, LONDON.

WRITE FOR CATALOGUE.

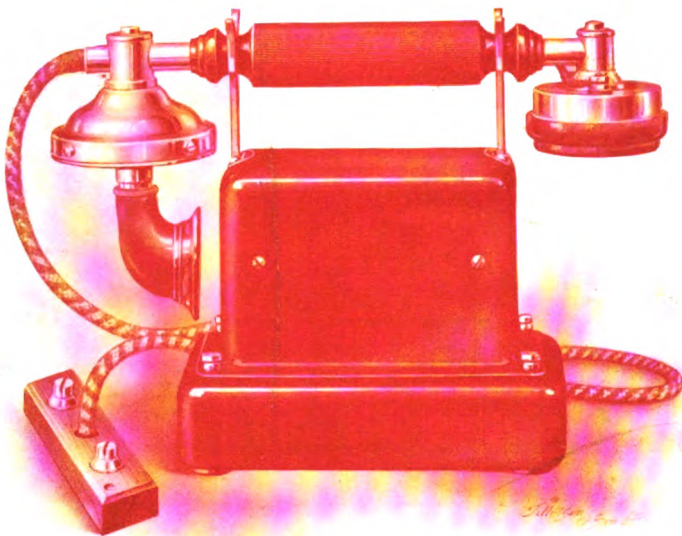
PEEL=CONNER

Central Battery ——— Hand-Combination ————— Telephone.

Suitable for either Wall or Desk service.

SIMPLE, DURABLE, AND EFFICIENT.

Write for Bulletin No. 2A.



PEEL-CONNER TELEPHONE WORKS, LTD.

Head Office :

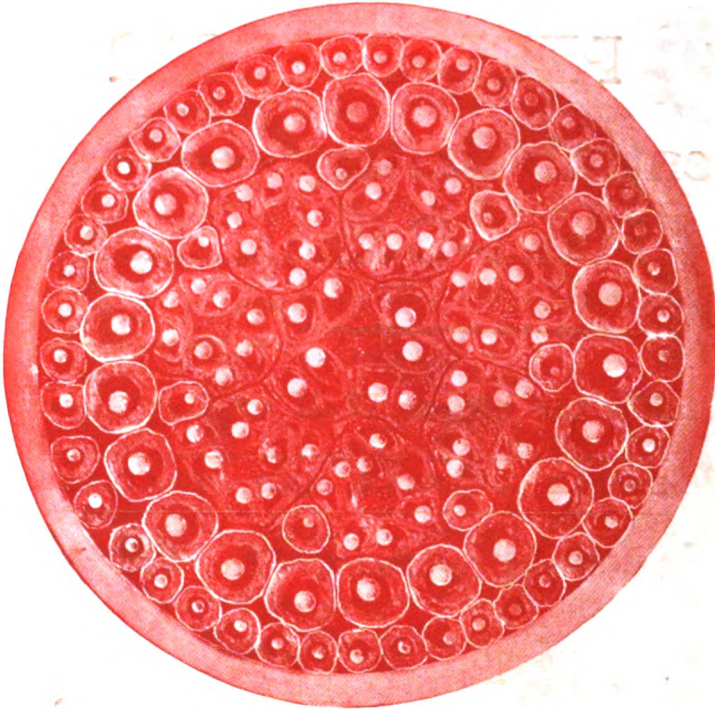
**PEEL WORKS,
SALFORD, LANCs.**

Telephones: 2183 & 2186 CENTRAL.
Telegrams:
SPRINGJACK MANCHESTER.

London Office :

**MIDLAND BANK CHAMBERS,
QUEEN VICTORIA ST., E.C.**

Telephone: 4766 CITY.
Telegrams:
PEELCONTEL CENT LONDON.



DRY CORE TELEPHONE CABLES.

**Electrical Plant of every description for
Power, Lighting, & Wireless Installations.**

JOHNSON AND PHILLIPS LTD
CHARLTON, LONDON. S.E.

ESTABLISHED 1875.

**This book is under no circumstances to be
taken from the Building**

[illegible]

form 410

- B'D NOV 22 1917

